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A POPULAR KEY TO THE DISTINCTIVE GROUPS OF THE LARGER FUNGI.*

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In the writer's courses in Mycology the student is encouraged, so far as it is possible, to determine the names of a number of fungi in each group studied. This procedure has been very unsatisfactory with any of the existing keys. There are, of course, keys and other methods of determining the genera and species of a number of the groups, such as Kauffman's "The Agaricaceæ of Michigan," Overholts' "The Polyporaceæ of the middle-western United States," Coker's "Clavarias of the United States and Canada," and others. There is, however, no easy method of determining the group to which a specimen may belong.

A key to the principal distinctive groups was therefore prepared on the basis of characters which can be readily seen in mature specimens as collected and in terms within the comprehension of the amateur in the study of the fungi. This key has been tested by use with students in the laboratory for three or four years and extensively revised several times as a result.

Although originally prepared for use by classes in Mycology, this key will probably prove helpful to others. There are doubtless many persons who desire to know at least the general group to which the fungi observed during rambles through the woods and fields may belong. This known, it is relatively easy to determine the genus and species, provided the necessary literature is available.

Most of the common fungi of appreciable size can be readily traced, by means of this key, to the proper group. Both the common and scientific names of each group are given, the common name in parenthesis. An effort has been made to

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segregate the distinctive kinds of fungi and, in consequence, the groups listed are of different ranks, including classes, subclasses, orders and families.

The use of microscopic characters is avoided so far as possible. Unfortunately certain fungi, even of relatively large size, can not be distinguished from certain others without study under the microscope. Microscopic characters are frequently added, usually at the end of the paragraph, as a further aid in determination when a microscope is available.

In general the key is built upon the dichotomous plan, that is, the reader, at each step, is given the choice of two sets of opposing or contrasting characters. For the sake of conserving space, however, this plan is not followed throughout, in several places three or more sets of contrasting characters being listed. In each case the paragraphs containing these sets of characters are all given the same number. In tracing a specimen through the key, therefore, all paragraphs bearing the same number should be read and compared with the specimen before a decision is reached.

KEY TO THE GROUPS OF THE LARGER FUNGI.

1. Macroscopic fungi; characterized by the development of fruiting bodies or spore masses whose nature and general structure can be determined without a microscope 2
1. Microscopic fungi; no fruiting bodies of conspicuous size developed (not treated in this key).
2. Fungus seen as a mass of threads or filaments (which are mostly without cross-walls) 3
2. Fungus not as above 4
3. Fungi aerial; at first usually white, later tawny to brown or black, usually with many minute brown or black sporangia (Filamentous Black Molds) ..... *Mucorales*
3. Fungi aquatic, always white (Water Molds) ..... *Saprolegniales*
4. Fruiting structures dusty, powdery or cottony at maturity, with or without an outer membrane 5
4. Fruiting bodies of compact structure, not dusty or cottony 8
5. Fungi parasitic on green plants 6
5. Fungi saprophytic, growing on the ground or on dead organic material 7
6. Spore masses or fungous growth white to smoky or violaceous; cottony (with conidiophores) or dusty (at first blister-like). (Downy Mildews and White Blisters) ..... *Peronosporales*
6. Spore masses black or dark brown; floral organs attacked mostly, sometimes the leaves or stems; spores not stalked (Smuts), *Ustilaginales*
6. Spore masses yellowish to bright red or reddish-brown, or if black or dark brown, the spores are stalked; leaves and stems mainly attacked (Rusts) ..... *Uredinales*
7. Fruiting bodies aerial, always arising from a mycelium; usually more than one-fourth inch in diameter; usually globose, but sometimes with a thick base or rather slender stalk; stalk never hair-like; all species with a surrounding membrane persistent until maturity; sometimes splitting radially and spreading out in starlike segments; threads (capillitium) without distinct surface markings and never forming a network (Puffballs, Earth-Stars) ..... *Gasteromycetæ*

7. Fruiting bodies (spore masses) aerial, arising from a mycelium, without a membrane, usually forming a flat layer, or if in tufts usually less than one-eighth inch in diameter (Blue and green molds).....*Aspergillaceæ*
7. Fruiting bodies subterranean, arising from a mycelium, with a thick firm membrane (False Truffles).....*Elaphomycetaceæ*
7. Fruiting bodies aerial, never arising from a mycelium; usually less than one-fourth inch in diameter and very numerous; sessile or with a hair-like stalk; surrounding membrane present or absent; capillitium often with spirals, rings, pegs or other markings, sometimes forming a network; if more than one-fourth inch across, fruiting body is either flat or globose; if globose the capillitium has distinct surface markings (Slime Molds).....*Myxomycetæ*
8. Plants grayish-green (some are yellow, olivaceous, brown or black); either circular and leaflike, or erect or pendulous and branched (some form a thin flat crust); papery, leathery or gelatinous in texture; growing on the bark of trees, on stumps, old timbers, rocks, or on the ground; (the plant structure as seen under the microscope consists of fungous elements and green or blue-green algal cells).....(*Lichens*)
8. Plants not grayish-green; fruiting bodies woody, corky or tough-leathery at maturity..... 9
8. Plants not grayish-green; fruiting bodies fleshy or jelly-like when fresh or wet, sometimes rather tough but not leathery.....14
9. Fruiting body rather flat, disklike or irregular in outline, usually black, splitting in more or less radiating lines at maturity (Tar Spot Fungi), *Phacidiales*
9. Fruiting bodies cup- or vase-shaped.....10
9. Fruiting bodies not as above.....11
10. Fruiting bodies containing egg-like bodies (Birds' Nest Fungi), *Nidulariales*
10. No egg-like bodies present; inner surface of fruiting bodies with microscopic sac-like asci containing spores (Cup Fungi)....*Pezizales*
11. Fruiting body consisting of a minute to rather large, hard or woody structure (stroma), sessile or stalked, with minute dots or pimples (perithecia within); or consisting of single or aggregated more or less spherical perithecia; perithecia containing spores in sac-like asci (Sphere Fungi).....*Pyrenomycetæ*
11. Fruiting body without minute pimples, perithecia and asci; often a stalked cap, or attached to the substratum by the side (shelving), or more or less flat and attached by all or most of the upper surface (resupinate)....12
12. Lower surface of cap or fruiting body with teeth, pores, pits or gills (leaflike plates or veinlike ridges).....13
12. Lower surface of cap or fruiting body even; without teeth, pores or gills; sometimes erect and branched (Smooth Fungi)..*Thelephoraceæ*
13. With spines or teeth, usually on the lower surface of a cap or fruiting body (Tooth or Spine Fungi).....*Hydnaceæ*
13. With shallow pits, or roundish, angular or elongated tubes or pores, sometimes with thin plates, either labyrinthiform or concentrically arranged on lower surface of cap or fruiting body; often on wood (Woody Pore Fungi).....*Polyporaceæ*
13. With thin or vein-like gills radiating from the stalk or point of attachment on lower surface of cap or fruiting body (Gill Fungi).....*Agaricaceæ*
14. Under surface of cap or fruiting body provided with thin or vein-like radiating plates or gills (Gill Fungi).....*Agaricaceæ*
14. Under surface of cap or fruiting body provided with pores or tubes; usually terrestrial (Fleshy Pore Fungi).....*Boletaceæ*
14. Fruiting body fleshy but not gelatinous, consisting of or bearing numerous teeth or spines (Tooth or Spine Fungi).....*Hydnaceæ*
14. Fruiting body of gelatinous or jelly-like consistency, shelflike, bearing numerous short teeth or spines on the lower surface (Jelly Fungi).....(*Tremellodon*) *Protobasideæ*
14. Fruiting body without gills, teeth or pores.....15

15. Plants usually with a strong disagreeable odor when fresh; fruiting body with a distinct sheathing cup at the base, usually stalked, but sometimes a more or less globose lattice-work, or rarely reduced to an egg-like structure which ruptures irregularly at the apex; spore mass greenish, at first firm, later deliquescing, usually borne at the apex of the stalk or on a special cap-like, lattice-like or branched, receptacle; fruiting body one to six inches long (Stinkhorns)..... *Phallales*

15. Plants usually without marked odor; fruiting body stalked or sessile without sheathing cup at base; spore mass not liquified at maturity.....16

16. Fruiting body disk-, saucer-, cup-, funnel-, or vase-shaped.....17

16. Fruiting body not as above.....18

17. Plants always parasitic; cup-like bodies yellow to orange, minute, usually in crowded clusters; spores borne in chains within the cups, usually angular (Rusts)..... *Uredinales*

17. Plants saprophytic, growing on wood, brown, jelly-like (Jew's ear), *Protobasideæ*

17. Plants usually saprophytic, rarely parasitic in this stage; cup-like bodies variously colored; minute to large; spores borne in sac-like asci lining the inner surface of the cup, not angular, (Cup Fungi)..... *Pezizales*

17. Plants saprophytic; cups not in crowded clusters; individual cups usually 1 cm. or more across; (spores borne on the exterior of the cup, not in chains nor in asci) (Smooth Fungi)..... *Thelephoraceæ*

18. Fruiting body gelatinous or jelly-like.....19

18. Fruiting body fleshy, not jelly-like.....20

19. Plants parasitic; gelatinous fruit body composed mainly of two-celled spores and their stalks (Rusts)..... *Uredinales*

19. Plants saprophytic, growing on soil; fruiting body green, often slimy, with distinct stalk and cap or head; head covered with a layer of sac-like asci with spores (Leotia)..... *Helvellales*

19. Plants saprophytic, growing on wood; fruiting body without distinct stalk or head; spores not in asci (Jelly Fungi)..... *Protobasideæ*

20. Fruiting body subterranean, globoid.....21

20. Fruiting body aerial; globoid or with thickened base or with slender stalk; compact within when young, later becoming more or less dusty, often with cottony threads (capillitium); with an outer thin or thick covering (peridium), the outer layer of which sometimes splits radially and spreads out in star-like segments (Puff-balls, Earth Stars)..... *Gasteromycetæ*

20. Fruiting bodies aerial; usually erect, but sometimes without a stalk, not globose.....22

21. Spores borne in persistent sacs (asci), asci with 1 to 4 rough spores (Truffles)..... *Tuberales*

21. Asci soon disappearing leaving the spores in a more or less dusty mass, (False Truffles)..... *Elaphomycetaceæ*

22. Fruiting body usually bright colored, but sometimes brown or blackish in age, with or without a head; partly covered with minute dots or pimples (perithecia, asci and ascospores within), (Colored Sphere Fungi)..... *Hypocreales*

22. Fruiting body without pimples; stalk-like, tongue-like, spatulate, capitate or pileate, unbranched; upper portion covered with a layer of asci containing spores (Morels, Earth Tongues).. *Helvellales*

22. Fruiting body without pimples and without asci; simple or branched, round in cross section; white, yellow, light brown or some light shade of red or purple (Coral Fungi)..... *Clavariaceæ*

22. Fruiting body without pimples and without asci; simple or branched, usually arising in a cluster; flattened in cross section (Smooth Fungi)..... *Thelephoraceæ*

THE INTERNAL ANATOMY OF THE MYDAS FLY.*

LYDIA A. JAHN

Introduction.

The following work is a report on the internal anatomy of the Mydas fly, *Mydas clavatus* Drury. In a survey of the literature dealing with certain insect groups it was found that nothing is known concerning the internal anatomy of the primitive flies of the Family *Mydaidæ*. Indeed, very little information of any kind is found which discloses the habits or life history of this large Dipteron. It was thought that a knowledge of the internal anatomy might indirectly reveal some of the life habits. A few carefully killed and fixed specimens of *Mydas clavatus* being available, a detailed dissection and microscopical examination was made. The Mydas flies are not common in Ohio, only two species have been reported from the state. The species used is a large, dusky, brown fly in which the dorsal sclerite of the second abdominal segment is marked by an orange band, and the antennæ are clavate and black. It is occasionally taken along Lake Erie on the sandy beach at Cedar Point, where the specimens used in this study were collected. Usually individuals of the group are found on dry, decaying logs or tree stumps. Owing to the scarcity of material it was necessary to use the same specimens for gross dissection and for the microscopical examination, consequently extreme care was taken during all manipulations.

I wish to express my thanks to Dr. C. H. Kennedy under whose supervision this investigation was carried on and also to Prof. J. S. Hine for the identification of specimens.

Methods.

Only three specimens were available, two females and a male. These flies were killed and fixed in Kahle's Fixative and then preserved in 70% alcohol.

Gross Dissection. It was slightly unwieldy to work with the legs and wings attached therefore these were first clipped from

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the body. The insect was then pinned out in a dissecting pan and covered with alcohol. All dissections were made under 70% alcohol with the aid of the binocular microscope. The alcohol was frequently renewed in order to insure preservation during gross dissection. The entire dorsal body wall was first carefully removed in minute particles after which the muscles of the thorax were taken out, exposing the alimentary canal for study. The nervous system and the reproductive systems were studied after the alimentary canal had been removed. No histological work was attempted with these systems, but drawings of the gross structures were made free hand while using the binocular microscope.

Microscopical Technique. The parts of the alimentary canal were cut into convenient lengths, run through the alcohols, cleared and imbedded in paraffin. All sections were cut seven microns thick and stained with a double stain of Delafield's haemotoxylin and eosin. The drawings were made with the aid of a camera lucida.

The Anatomy of the Digestive System.

The alimentary canal is a comparatively short tube and suggests the carnivorous habit. In the higher Diptera the digestive system may reach a length almost twice that of the insect itself, and appears as a convoluted mass filling the abdomen. In the Mydas fly, however, it extends as a straight tube throughout its length with the exception of several convolutions in the hind gut where it loops back upon itself twice. Plate I, Figure II.

In insects the fore gut is an invagination of the ectoderm at the anterior end and is called the stomodaeum. The hind gut is formed in a similar fashion and is a posterior ectodermal invagination called the proctodaeum. Connecting these two regions is the mid gut which is derived from endodermal tissue. In correlation with the external epithelium the epithelial lining of the fore and hind guts secretes chitin which is found lining these regions as a definite membrane. The parts of the alimentary canal will be discussed in the following order:

A. Mouthparts.
B. Fore Gut.
   1. Pharynx.
   2. Oesophagus.
   3. Oesophageal Valve.
   4. Salivary Bulb.
   5. Salivary Duct.
   6. Salivary Glands.
   7. Crop.
C. Mid Gut.
   1. Gastric caeca.
   2. Stomach (proper).
   3. Pyloric Valve.
D. Hind Gut.
   1. Malpighian Tubules.
   2. Intestine.
      a. Rectum.

I. GROSS STRUCTURES.

A. Mouthparts.

The mouthparts of the Mydas fly have been worked out and figured by Peterson (1916), and present a type of structure similar to that in the robber flies and horse flies, but distinctly less specialized. This is another evidence of the predaceous method in acquiring food, although there is no record which shows that the adult Mydas fly has ever been observed actually attacking another animal.

B. Fore Gut.

The *pharynx* is the anterior end of the alimentary canal and lies just posterior to the mouth. Food is conveyed by means of the pharynx to the oesophagus; in this fly there is no essential difference between the structure of the pharynx and the oesophagus.

The *oesophagus* begins posterior to the pharynx and extends to the anterior end of the mid gut. Its diameter gradually increases in size until the posterior end is twice as large as the anterior. The oesophagus gives the appearance of an opaque, chalky white tube.

The *crop* is a dilatation of the ventral wall of the oesophagus. This is an out-pocketing which is so pronounced in the Mydas fly that the crop itself lies in the abdomen and is connected with the oesophagus by means of a long slender tube. The tube lies just beneath the stomach, branching off at the posterior end of the oesophagus and continuing until it reaches the second abdominal segment. The crop functions as a food reservoir.

The *oesophageal valve* represents the posterior limit of the fore intestine and is really a prolongation of the fore gut into the mid gut.

The *salivary glands*.—"The salivary duct extends through the hypopharynx to its distal end." (Peterson). Here the tube enlarges to form the salivary bulb, then narrows again and eventually passes upward and back through the head and neck. Before it leaves the head it divides forming two ducts which extend through the neck to the thorax and lie, one on either side of the oesophagus close to the anterior end of the thoracic cavity as thickened convoluted tubes. These posterior thickenings are the glands proper. Secretions pass from the glands to the ducts and are then transferred to the hypopharynx. There they are mixed with the food and are probably the first agents in digestion.

C. Mid Gut (Stomach).

The *gastric caeca* are two pouches which represent out-pocketings in the anterior end of the *stomach* and lie at right angles to the remainder of the alimentary canal. They occupy the entire anterior end of the thoracic cavity. Numerous projections on the surface of the caeca appear as evaginations which increase the secreting surface. Similar secreting sacs are also found posterior to the caeca but not as extensively, and they do not occur on the posterior half of the stomach. The stomach extends to the pyloric valve. It has a uniform diameter for two-thirds of its length and then gradually increases in size.

The *pyloric valve* is the posterior limit of the mid gut. It is the point of insertion of the malpighian tubules.

D. Hind Gut (Intestine).

The *malpighian tubules* define the anterior limit of the hind gut. There are four tubes, two branching from the dorsal surface and two branching from the ventral surface. These twine in and out among the digestive organs and other body structures. They are excretory in function, extracting urinary wastes from the body.

The *intestine* includes all the structures of the hind gut. The ileum is the smaller anterior end of the hind gut and the colon the larger posterior part. In the Mydas fly there is no distinguishable difference in the size or structure of these regions.

The *rectum* represents an abrupt enlargement of the posterior end of the hind gut. The surface of the rectum is spotted with the bases of rectal glands or papillæ which project into the rectal lumen. These are confined to three general rows and are about thirty-three in number. No definite function is known for these glands.

II. HISTOLOGICAL STRUCTURES.

A. Fore Gut.

The following tissues can be demonstrated in a histological examination: (1) a chitinous intima, (2) epidermal layer, (3) longitudinal muscle layer, (4) circular muscle layer. The innermost layer is an *intima of chitin* which is secreted by the epidermal cells. It is a non-cellular membrane, and forms a thick layer of very flexible chitin. The next layer is composed of flattened *epithelial cells*. In most places it was possible to distinguish cell walls quite easily but in others the entire layer resembled a syncytium. Immediately outside the epithelium is a layer of *longitudinal muscle fibers*. These are arranged in the form of a dense network several fibers in thickness. The outermost layer of the oesophagus is composed of *circular muscle fibers* which occur in scattered bundles. See Figures I and II, Plate II.

The *salivary glands* are part of the fore gut and are therefore ectodermal in origin. They are composed of a single layer of columnar cells which contain large nuclei. There is an intima of chitin present which lines these glands. Figure IV, Plate II shows the salivary gland as it appears in cross-section.

The *oesophageal valve* is the division between the fore and mid gut and is formed by an invagination of the fore gut into the mid gut. Several kinds of epithelial cells are found in the valve making it impossible to determine just which cells are derived from the fore gut and which from the mid gut. In the oesophagus are found the flattened epithelial cells described above. At the entrance to the valve the form of the cells changes abruptly and a disc composed of columnar epithelium is formed. Immediately posterior to the disc the cells decrease in size and number and their long axis becomes parallel to the position of the digestive tract. The tube is very narrow here. Figure I, Plate II shows this narrow passage filled with chitin and the tips of underlying cells which have extended inward so that they almost close the lumen. At the posterior margin of the valve the epithelial cells are considerably elongated and very numerous. These cells form a heavy collar which makes a thick wall at the anterior end of the stomach.

The ring of cells at the anterior and the collar of cells at the posterior end give the valve the appearance of an ambidisc. The region between the two discs is heavily supplied with circular muscles, which possess the ability to shut off the passage to the stomach and thus afford an opportunity for food to pass to the crop. The epithelial cells in the mid gut just posterior to the oesophageal valve are thicker and not as long as those found in the posterior disc. Their inner surfaces are covered by a peritrophic membrane which arises at the anterior end of the mid gut and appears as though it were secreted by the cells of the digestive epithelium.

The tube leading to the *crop* begins immediately anterior to the first disc of cells in the valve. This tube is lined with an intima of chitin, then a layer of squat epithelial cells. The outside is provided with a heavy layer of circular muscles.

In Figure I, Plate II the oesophageal valve and the tube leading to the crop are shown in longitudinal section.

B. Mid Gut.

A histological examination of the mid gut reveals the following tissues: (1) peritrophic membrane, (2) enteric epithelium, (3) circular muscle layer, (4) longitudinal muscle layer. The mid gut shows a non-specialized type of structure which is common to lower insects generally. The *peritrophic membrane* appears to be secreted by the gastric epithelium. It appears as a distinct non-cellular membrane which functions as a protection to the epithelium. It covers the cells and shows up very distinctly in cross section. Figure III, Plate II shows how closely the membrane lies to the epithelial layer. The next layer is that of the actively functioning endodermal *epithelial cells*. There is no specialized type of nidi or cell nests. The cells which are destroyed in holocrine secretion are replaced by others which are narrow, elongate cells at the bases of the active, secreting cells, and are interspersed among them. They are not confined to any definite region but occur singly, scattered among the functioning cells. The digestive epithelium is composed of columnar cells which are grouped together forming projections into the lumen of the alimentary canal. The cells are narrow at their bases and flare at their tips, due perhaps to the crowded condition of the developing cells. The flaring outer ends of the cells form irregular projecting folds. At the very apex of these cells are numerous granules which resemble the basal bodies of cilia, and form a distinct line around the outer edge of the cells when viewed in cross section.

Between the cells of the digestive layer and the muscles layer is an area filled with numerous branching filaments which stain red with eosin. The finger-like extensions of this layer are projected between the cells of the epithelium. The branched condition and the extension of the filaments between the cells has led the writer to believe that they are tracheoles whose tips are found among the cells.

The bundles of *circular muscle* lie outside the above layer and form a closely united ring around the stomach wall. The *longitudinal muscle* fibers are found in groups just outside the circular layer. The muscles are not closely united and form loose bundles usually consisting of three or five fibers.

C. Hind Gut.

The tissues of the hind gut are arranged in the following manner: (1) an inner intima of chitin, (2) an epithelial layer, (3) a circular muscle layer, (4) a longitudinal muscle layer and (5) around the malpighian tubule there is a peritoneal membrane.

The *plyoric valve* represents the boundary between the mid and hind guts. The epithelial cells of the mid gut are greatly elongated and their tips are directed posteriorly, projecting, as a ring into the cavity of the hind gut. The malpighian tubules are inserted between the mid and hind guts. At their origin the tubules are formed of slender, elongate cells which are crowded very closely together. These cells do not possess the striated border common to the cells in the malpighian tubule. The cells gradually increase in size going away from the basal end of the tubule, and contain larger nuclei. Figure III, Plate III shows a longitudinal section through the pyloric valve.

In the region behind the pyloric valve and just anterior to the rectum is an area in which the intima forms a thin layer that appears as a heavy line around the inner edges of the epithelial cells. The latter, as found in this region of the intestine, are almost square in shape, and appear like columnar cells. The muscle layers are not highly developed.

In the *malpighian tubules* the epithelial cells are very large, and their inner ends are lined with a striated border which appears as if composed of cilia. At the bases of the striations granules are found which show up very distinctly. Whether or not these are true cilia is unknown. Figures I and II, Plate III show sections through the malpighian tubules.

In the *rectum* the intima of chitin is not as thick as that in the fore gut but is considerably thicker than the same layer elsewhere in the intestine. It extends as a wavy membrane over the epithelial cells. Figure V, Plate III shows the arrangement of the tissue in the rectum. The epithelium is composed of flattened cells much like those in the fore gut. The circular muscle layer is developed to a high degree. The bundles appear to be piled up in heaps, giving the inside a folded appearance. The longitudinal muscle layer contains larger fibers than have been encountered anywhere else in the gut.

The *rectal papillæ* project finger-like into the lumen of the intestine. There are approximately thirty-three papillæ whose external openings dot the surface of the organ, and are confined to three general rows. In the higher Diptera the number of papillæ is much smaller. Each papilla is composed of large epithelial cells which probably are pushed inward due to the proliferation of cells from an active, growing region at the tip. The cells here are smaller than at the base of the papilla, where large irregular cells occur. The cells are arranged in a double row, each row a single cell in thickness. Between these two rows of cells numerous tracheoles are found. There is a smooth layer of chitin around the papilla without spines or other structures common to more specialized forms of papillæ. The rectal papilla of the Mydas fly shows this structure in its primitive form.

THE NERVOUS SYSTEM.

I. Brain.
  a. Protocerebrum.
    Protocerebral lobes.
    Optic lobes.
  b. Deutocerebrum.
    Antennal Nerves.
  c. Tritocerebrum.
  d. Suboesophageal ganglion.

II. Ventral Nerve Cord.
  a. Ganglia.
  b. Lateral Nerves.

A superficial examination of the nervous system of the Mydas fly reveals the following external structures. The brain or cephalic ganglia lie in a fused mass in the head. A double row of united ganglia lies on the ventral floor of the thoracic and abdominal cavities.

The most obvious structure and one which includes the greatest part of the brain is called the *protocerebrum*. It is composed of two distinct parts, the protocerebral lobes and the optic lobes. The protocerebral lobes are fused along the median line and form a bilobed mass, which indicates its original derivation from a pair of ganglia in the optic segment. This nerve mass enervates the compound eyes and the ocelli. At the junction of the protocerebral lobes three nerves are given off. Two of these unite at their distal ends to form the saddle shaped structure observed in side view in Figure VIII, Plate I. This structure is pigmented on its outer border over the area that lies beneath the external ocelli. The third nerve enlarges at its distal end to form a bulb-like organ which is also pigmented on its outer surface and lies just beneath the median ocellus. The optic stalk is continuous with the protocerebrum and enlarges to form the huge optic lobes. These lobes form most of the brain and are developed to the same extent as the compound eye.

The deutocerebrum lies a little anterior and ventral to the protocerebrum. The antennal nerves are given off from this portion of the brain.

The third part of the brain or the tritocerebrum lies posterior and ventral to the deutocerebrum and is composed of two united lobes. The mouthparts are enervated from nerves which arise from this part of the brain and in the *sub-oesophageal ganglion* which is indistinguishable from the tritocerebrum.

The nerve cord lies in a double row of united ganglia along the ventral wall of the thorax and abdomen. Only two pairs of ganglia are found in the thorax showing that there is a concentration of ganglia in this region. From these ganglia nerves are given off which supply the wings and legs. From the ganglia in the abdomen pairs of lateral nerves arise. There is some fusion of ganglia in the posterior of the abdomen since three pairs of nerves arise here instead of the usual one pair. Centralization of ganglia has progressed to some extent in both the thorax and abdomen but not appreciably.

The outstanding features of the nervous system in the Mydas fly are the marked development of the optic lobes and the cephalization in the thoracic and abdominal ganglia. This condition shows the first stages in cephalization which has proceeded to such a marked degree in the muscid flies.

THE MALE REPRODUCTIVE ORGANS.

I. Testes.
II. Vas deferens.
III. Ejaculatory sac.
IV. Ejaculatory duct.

The *testes* are considerably smaller than the ovaries. A pair of them lies in the third abdominal segment, ventral to and on each side of the alimentary canal. The testes are spherical bodies which have a diameter slightly greater than the vas deferens.

The *vas deferens* consists of a pair of tubes which extend from the testes to the posterior. They are white and coil several times before they finally unite to form a single tube. In the posterior of the abdomen these tubes have formed such a convoluted mass that in the specimen used it was impossible to determine the exact place at which the tubes united. In Figure V, Plate I the dotted lines indicate the joining of the two tubes to form one as it might occur. After the tubes of the vas deferens have joined the diameter of the resulting tube remains the same as that of the other tubes until it reaches its posterior end. Here it narrows gradually and finally merges with the ejaculatory duct. The latter begins immediately back of the entrance to the ejaculatory sac.

The *ejaculatory sac* is a blind, pouch-like tube which branches to the right of the vas deferens. Its diameter is the same as that of the vas deferens where it branches off. Gradually, however, the tube enlarges and forms a large sac.

The *ejaculatory duct.*—The remainder of the system posterior to the branching of the ejaculatory sac is called the ejaculatory duct. It has a very large diameter as it nears its end.

THE FEMALE REPRODUCTIVE ORGANS.

I. Ovaries.
a. Ovarioles.
II. Oviducts.
III. Vagina.
IV. Seminal receptacles.
V. Colleteria.

The female Mydas fly in which the reproductive organs were observed had apparently been fertilized and engaged in egg laying. The abdomen was distended by the numerous eggs which filled the body cavity. Some of these were already equipped with chitinous shells. Figure IV, Plate I shows a drawing made while the eggs were still in place in the abdomen.

Ovaries.—The ovaries are composed of numerous sac-like structures called ovarioles. These are joined at their bases to form a duct which eventually unites with one of the oviducts. It was impossible to trace the connections between the ovarioles in this specimen. The ovarioles and their contents completely filled the abdomen and were firmly pressed together, distorting some of the other organs. The *ovarioles* are tubes in which the eggs are formed. Each ovariole appears to end freely in the body cavity without any attachment to the body wall or other internal structure. The eggs lie as chains in an ovariole, one behind the other. The oldest eggs lie nearest the union with the oviduct. An ovariole consists of several distinct parts. The distal end is termed the terminal filament. A thin peritoneal layer covers the outside of an

ovariole and is continuous with the oviduct. Within this lie the developing ova. The type of egg here found clearly shows that *Mydas clavatus* does not deposit fully formed larvæ but the egg must undergo a period of incubation after it is laid.

The *oviducts* are thin walled tubes which lead from the ovaries to the vagina. They extend posteriorly and form the vagina after they unite.

The *vagina* extends from the union of the oviducts to the outside.

There are three *seminal receptacles* which enter the vagina at the point where it opens to the outside. Each receptacle is a blind, pouch-like tube which has an inner chitinous lining. This is visible through the external layers and gives a faint yellow tinge to the tubes at their tips. As the eggs pass through the vagina sperms are transferred from the seminal receptacles and enter the eggs through the micropyle.

The *colleteria* are two long white tubes which enter the vagina just posterior to the seminal receptacles. Figure III, Plate I shows these pushed back out of the abdominal cavity. They lie at either side of the vagina in the normal fly. These glands are functional in that they produce a sticky substance. The substance produced in the Mydas fly probably serves to attach the eggs to some object when oviposited.

The *egg* is one millimeter in diameter. At the end which lies toward the anterior of the mother is a faint white spot which shows up distinctly against the brown color of the egg. This is called the micropyle.

Summary.

The Mydas fly is a representative of one of the primitive families of Diptera. A study of the internal anatomy confirms the evidence derived from the external anatomy and other sources in regard to their relative systematic position.

The alimentary canal is a generalized food tube which shows no particular specialization in any direction. The length of the tract and the structure of the mouthparts indicates that the fly is carnivorous in its food habits.

The concentration of ganglia has not proceeded to any great degree, while centralization of the whole system is greatly like that of lower Diptera.

The chorion of the egg is composed of a hard chitinous material and precludes the idea that the female is able to deposit mature larvæ. This characteristic of the eggs as found in the abdomen of the female necessitates a longer or shorter period of incubation after the egg has been deposited.

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EXPLANATION OF PLATES.

Plate I.

Fig. I. A dorsal view of the nervous system showing the position of the brain, ganglia, and the main nerves which branch from the ventral nerve trunk.
Fig. II. A dorsal view of the alimentary canal.
Fig. III. A dorsal view of the female reproductive system, which shows all parts of the system except the ovaries.
Fig. IV. The abdomen of the female Mydas fly showing the arrangement of the eggs.
Fig. V. The male reproductive system shown in a dorsal view.
Fig. VI. Side view of the brain of the Mydas fly with the optic lobes removed.
Fig. VII. Dorsal view of the brain as it lies in the head.
Fig. VIII. Dorsal view of the brain after it has been tipped forward in order to show the sub-oesophageal ganglion.

Plate II.

Fig. I. Longitudinal section through the oesophageal valve, oesophagus, gastric caeca, and the tube leading to the crop.
Fig. II. A view of part of the oesophagus taken from a cross-section.
Fig. III. Part of the cross-section through the mid-gut, which shows the arrangement of the epithelium into papillæ-like projections.
Fig. IV. Cross-section of a salivary gland.

Plate III.

Fig. 1. Cross-section of a malpighian tubule.
Fig. II. Longitudinal section of a malpighian tubule.
Fig. III. Longitudinal section through the pyloric valve showing the insertion of a malpighian tubule.
Fig. IV. Cross-section through the hind gut.
Fig. V. Longitudinal section of the rectum which is cut through a rectal papilla.

ABBREVIATIONS.

Ant. Nerv.....Antennal Nerves.
Circ. Mus.....Circular Muscle.
Col.....Colleteria.
Ej. Duct.....Ejaculatory Duct.
Ej. Sac.....Ejaculatory Sac.
Epith.....Epithelium.
Gast. Caec.....Gastric Caecæ.
Int.....Intestine.
Long. Mus.....Longitudinal Muscle.
Malp. Tub.....Malpighian Tubule.
Oes.....Oesophagus.
Opt. Lobe.....Optic Lobe.
Ovid.....Oviduct.
Per. Memb.....Peritrophic Membrane.
Perit. Memb.....Peritoneal Membrane.
Rec.....Rectum.
Sal. Bulb.....Salivary Bulb.
Sal. D.....Salivary Duct.
Sal. Gl.....Salivary Gland.
Sp. Rec.....Sperm Receptacle.
Stom.....Stomach.
Trach.....Tracheoles.
Ts.....Testes.
Vag.....Vagina.
Vas. Def.....Vas Deferens.
Vent. Nerv. Cord. Ventral Nerve Cord.

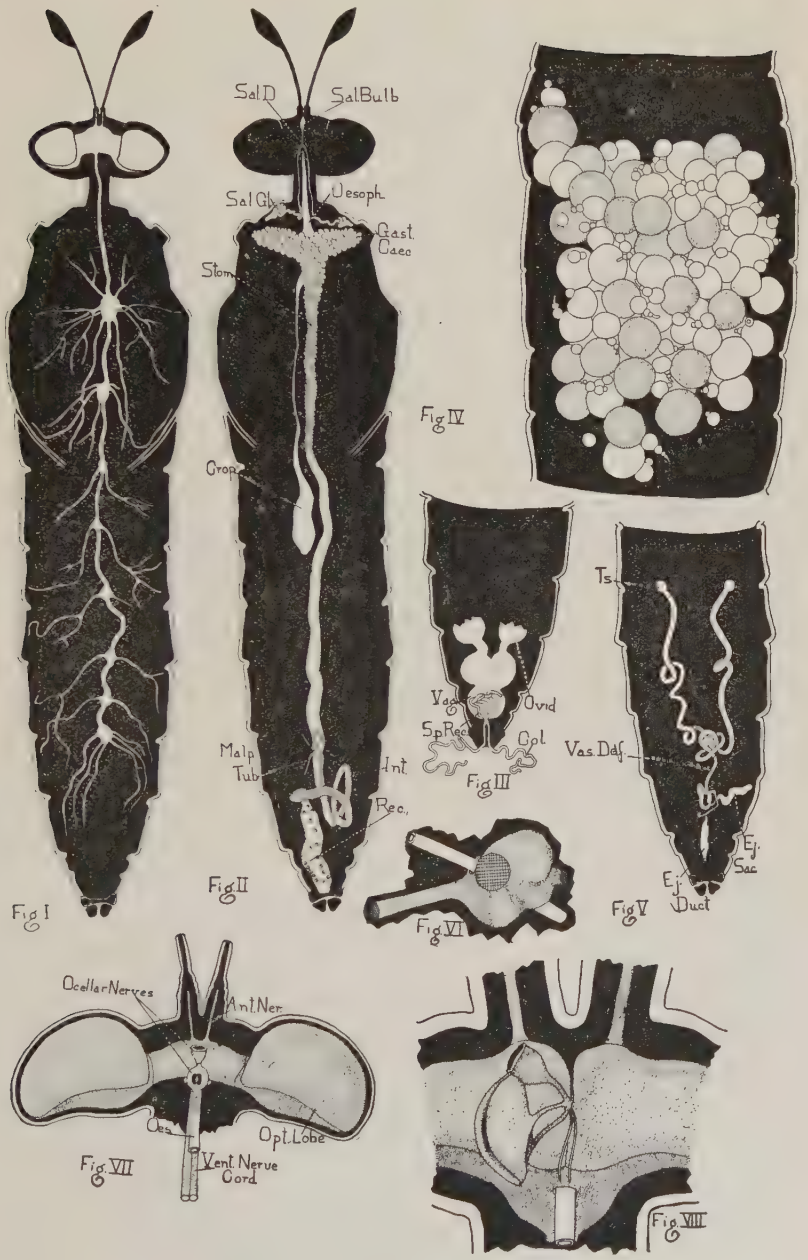
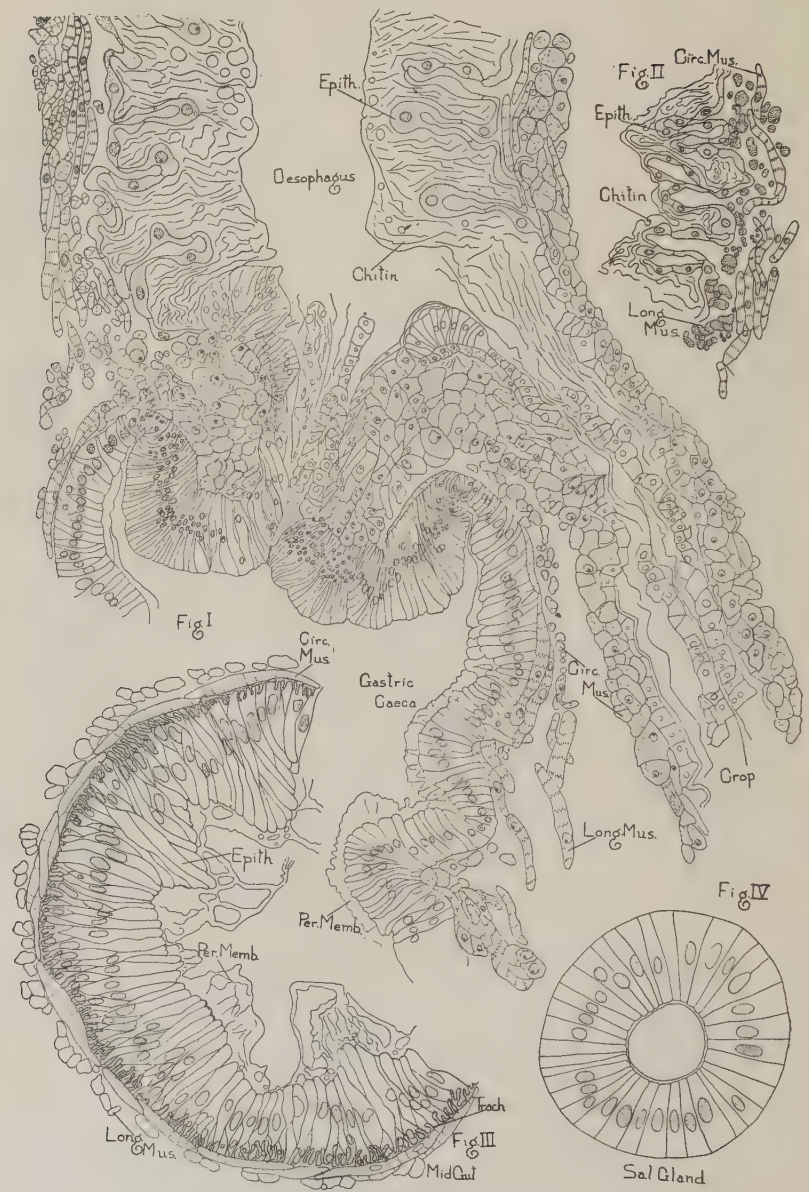
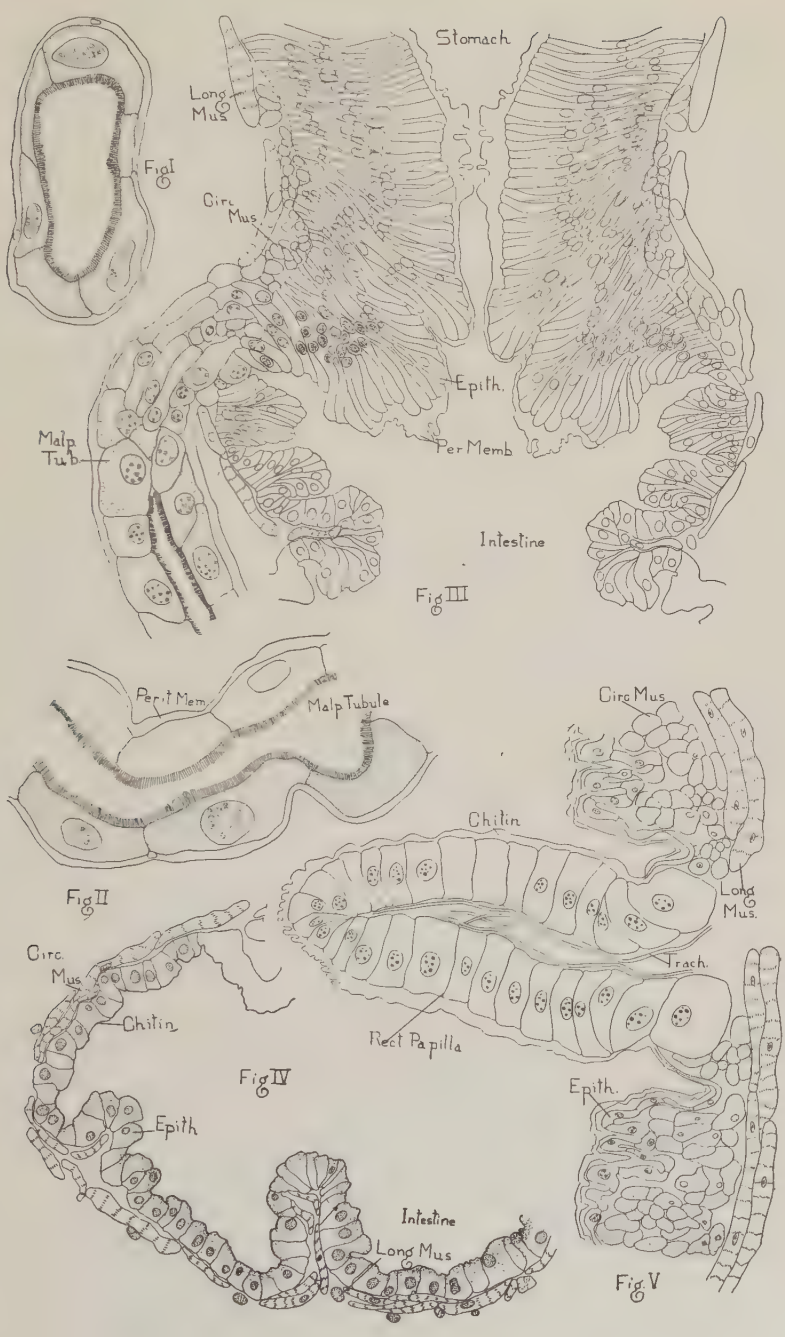


Fig I
Sal D
Sal Bulb
Sal Gl
Oesoph
Gast Caec
Stom
Crop
Malp Tub
Int
Rec
Fig II
Fig IV
Vag
Ovid
Sp Rec
Opl
Fig III
Ts
Vas Def
Ej Sac
Ej Duct
Fig V
Fig VI
Ocellar Nerves
Ant Ner
Opt Lobe
Ves
Vent Nerve Cord
Fig VII
Fig VIII


Epith.
Oesophagus
Chitin
Fig.II
Circ.Mus.
Epith.
Chitin
Long Mus.
Fig I
Circ. Mus.
Gastric Caeca
Circ. Mus.
Crop
Long.Mus.
Epith
Per.Memb.
Per.Memb.
Fig.IV
Trach
Long Mus.
Fig.III
Mid Gut
Sal Gland


Stomach
Long Mus
Fig I
Circ Mus
Epith.
Per Memb
Malp Tub
Intestine
Fig III
Perit Mem
Malp Tubule
Fig II
Circ Mus
Chitin
Long Mus.
Trach.
Circ Mus
Chitin
Rect Papilla
Fig IV
Epith.
Epith
Intestine
Long Mus
Fig V

ADDITIONS TO THE CATALOG OF OHIO VASCULAR PLANTS FOR 1929.*

JOHN H. SCHAFFNER.

The additions to the State Herbarium have been both numerous and important, many showing decided extensions of known ranges and others adding species new to the list. Dr. F. W. Pennell has completed his monograph of the North American species of Agalinis and our list is now corrected in agreement with his determinations. Dr. E. T. Wherry has studied our species of Phlox. Thus we are learning not only what we have but the exact localities where botanists can find the plants. Our specimens of Helianthus were all studied by Prof. Elba E. Watson of the Michigan Agricultural College and a revised list of the species is presented below, corresponding to his recently published work—Contributions to a Monograph of the Genus Helianthus. Mich. Acad. Sci. Arts and Letters 9:305–475. 1929. The study of a genus by a specialist nearly always brings improvement and change which means progress. Change brings temporary inconvenience, but the individual must necessarily be readjusting himself to an advancing world, in plant taxonomy and geography as well as in all other progressive sciences.

4. *Botrychium lanceolatum* (Gmel.) Angs. Lanceleaf Grape-fern. "Common in Beech-Maple woods in Western half of Monroe Twp.," Ashtabula Co. Lawrence E. Hicks.

20. *Asplenium pinnatifidum* Nutt. Pinnatifid Spleenwort. Buchtel, Athens Co. Len Stephenson.

26. *Asplenium montanum* Willd. Mountain Spleenwort. "Abundant on all of the cliffs on east side of gulch." White's Gulch, Liberty Twp., Jackson Co. Laurel Twp., Hocking Co. Floyd Bartley and Leslie L. Pontius.

40. *Dennstaedtia punctilobula* (Mx.) Moore. Boulder-fern. Red Hills region, along Duncan Run, Genoa Twp. and Highbanks, Liberty Twp., Delaware Co. R. B. Gordon and F. B. Chapman.

47. *Azolla caroliniana* Willd. Carolina Azolla. "Abundant in the north end of Baumgardner's Lake," Jackson Twp., Franklin Co. Arthur R. Harper. (This was planted there in the spring of 1929 by Lawrence E. Hicks.—J. H. S.) Portage Lakes, near Akron, Summit Co. Glenn W. Blaydes.

53. *Equisetum laevigatum* A. Br. Smooth Scouring-rush. Licking Narrows, Toboso, Licking Co. R. B. Gordon and Hiram F. Thut. Big Darby Creek, Prairie Twp., Franklin Co. R. B. Gordon.

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*Papers from the Department of Botany, The Ohio State University, No. 255.

54. *Equisetum fluviatile* L. Water Horsetail. Bennett Lake, Washington Twp., Holmes Co. Also in Long Pond, Coventry Twp., Summit Co.; Muzzy Lake, Rootstown Twp., Portage Co.; and Black Run Pond, Mentor Twp., Lake Co. Lawrence E. Hicks. Indian Lake, Logan Co. W. H. Camp.
59. *Lycopodium porophilum* Lloyd & Und. Rock Club-moss. Hocking Twp., Fairfield Co. L. E. Hicks and E. S. Thomas. Ofer Hollow, Jackson Co. Floyd Bartley and Leslie L. Pontius.
61. *Lycopodium clavatum* L. Common Club-moss. Toboso, Licking Co. R. B. Gordon and Hiram F. Thut. Corning, Perry Co. R. D. Book.
69. *Pinus rigida* Mill. Pitch Pine. Colerain Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
70. *Pinus virginiana* Mill. Scrub Pine. Byington, Mifflin Twp., Pike Co. Reported by E. S. Thomas.
71. *Pinus echinata* Mill. Short-leaf Yellow Pine. Colerain Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
76. *Taxus canadensis* Marsh. American Yew. Put-in-Bay (South Bass) Island, Ottawa Co. R. C. Osburn and L. H. Tiffany.
92. *Potamogeton lucens* L. Shining Pondweed. Baumgardner's Pond, Jackson Twp., Franklin Co. Hiram F. Thut.
100. *Potamogeton pusillus* L. Small Pondweed. Baumgardner's Pond, Jackson Twp., Franklin Co. Hiram F. Thut.
121. *Typha angustifolia* L. Narrow-leaf Cat-tail. Jerusalem Twp., Lucas Co. Louis W. Campbell. Oak Hill, Jackson Co. Conrad Roth. Near Columbus, Franklin Co. R. B. Gordon and H. F. Thut.
130. *Lemna cyclostasa* (Ell.) Chev. Valdivia Duckweed. Mentor Twp., Lake Co. L. E. Hicks.
132. *Wolffiella floridana* (J. D. Smith) Thomp. Florida Wolffiella. Green Twp., Summit Co.; Suffield Twp., Portage Co. L. E. Hicks.
133. *Wolffia columbiana* Karst. Columbia Wolffia. Collected in Ross, Licking, Richland, Summit, Portage, and Lake Counties by L. E. Hicks.
134. *Wolffia punctata* Griseb. Punctate Wolffia. Near Fredericktown, Knox Co. L. E. Hicks.
138. *Cyperus inflexus* Muhl. Awned cyperus. Abundant in ooze at north end of Baumgardner's Lake, Jackson Twp., Franklin Co. Arthur R. Harper.
139.2. *Cyperus retrofractus* Torr. Rough Cyperus. Benton Twp., Hocking Co. Floyd Bartley.
176. *Rynchospora glomerata* (L.) Vahl. Clustered Beak-rush. Liberty Twp., Ross Co. Floyd Bartley and Leslie L. Pontius. Silver Lake, near New Carlisle, Clark Co. John H. Schaffner.
181. *Scleria verticillata* Muhl. Low Nut-rush. Silver Lake, near New Carlisle, Clark Co. John H. Schaffner; Ira May Swamp, Wayne Twp., Pickaway Co. Leslie L. Pontius and Floyd Bartley.
201. *Carex trisperma* Dew. Three-fruited Sedge. Hillsboro, Highland Co. Katie M. Roads.
223. *Carex leptalea* Wahl. Bristle-stalked Sedge. Hillsboro, Highland Co. Katie M. Roads.
227. *Carex hirtifolia* Mack. Pubescent Sedge. Hillsboro, Highland Co. Katie M. Roads.
278. *Carex folliculata* L. Long Sedge. "Abundant in swamps," Wayne Twp., Ashtabula Co. Lawrence E. Hicks.
340. *Eragostis capillaris* (L.) Nees. Capillary Love-grass. Hillsboro, Highland Co. Katie M. Roads.
345. *Korycarpus arundinaceus* Zea. American Korycarpus. Jefferson Twp., Adams Co. Conrad Roth.
349. *Phragmites phragmites* (L.) Karst. Common Reed-grass. Silver Lake, near New Carlisle, Clark Co. John H. Schaffner. Also near Lancaster, Fairfield Co. Glenn W. Blaydes.
352. *Arrhenatherum elatius* (L.) Beauv. Oat-grass. Bexley, Franklin Co. E. S. Thomas.
353. *Trisetum pennsylvanicum* (L.) Beauv. Marsh False-oats. "In a swamp near Hillsboro." Liberty Twp., Highland Co. Katie M. Roads.

359. *Nothoholcus lanatus* (L.) Nash. Velvet-grass. South Perry, Hocking Co. E. S. Thomas. Also Loudonville, Ashland Co. Glenn W. Blaydes. Conneaut Twp. and Monroe Twp., Ashtabula Co. Lawrence E. Hicks.
372. *Hordeum vulgare* L. Common Barley. "Escaped along roadside," Fredericktown, Knox Co. Lawrence E. Hicks.
372a. *Hordeum vulgare trifurcatum* Schlecht. Hooded Barley. "Escaped along roadside," Fredericktown, Knox Co. Lawrence E. Hicks.
383. *Sporobolus asper* (Mx.) Kunth. Long-leaf Rush-grass. Minerva Park, Franklin Co. R. B. Gordon and F. M. Chapman. Earlier specimens in the herbarium are from "Steelton," "Sellsville," in Columbus.
403. *Muhlenbergia umbrosa* Scribn. Wood Muhlenbergia. "In woodland," East Williamsfield, Ashtabula Co. Lawrence E. Hicks.
410. *Aristida dichotoma* Mx. Poverty-grass. "In woodland," East Williamsfield, Ashtabula Co. Lawrence E. Hicks.
415a. *Phalaris arundinacea picta* L. Ribbon-grass. "Escaped along roadside near Kellogsville," Ashtabula Co. Lawrence E. Hicks.
455. *Echinochloa walteri* (Pursh) Nash. Marsh Cockspur-grass. Williamsfield Twp., Ashtabula Co. Lawrence E. Hicks.
464. *Zizania aquatica* L. Wild Rice. "Old canal bed," Wayne Twp., Pickaway Co. Floyd Bartley and Leslie L. Pontius.
469.1. *Andropogon elliottii* Chapm. Elliott's Beard-grass. Near New Straitsville, Perry Co. Lawrence E. Hicks, Edward S. Thomas and Len. Stephenson.
475. *Lilium superbum* L. Turk's-cap Lily. Jackson Twp., Pickaway Co. Leslie L. Pontius and Floyd Bartley.
477. *Lilium philadelphicum* L. Philadelphia Lily. Shawnee State Forest, Scioto Co. R. B. Gordon and Conrad Roth.
481.2. *Nothoscordum bivalve* (L.) Britt. False Garlic. Greenbrier Twp., Adams Co. E. Lucy Braun. (Braun Herbarium).
482. *Allium tricoccum* Ait. Wild Leek. "In woods along Conneaut R." Farnham, Ashtabula Co. Lawrence E. Hicks.
487.1. *Scilla nonscripta* Hoff. & Link. Common Blue Squill. "Spreading in a vacant lot." Hillsboro, Highland Co. From western Europe. Kate M. Roads.
487.2. *Scilla sibirica* Andr. Siberian Squill. From Russia and Siberia. Propagates itself from seed and spreads when planted about dwellings. Columbus, Franklin Co. John H. Schaffner.
511. *Disporum lanuginosum* (Mx.) Nich. Hairy Disporum. Harrison Twp., Ross Co. Floyd Bartley.
519. *Clintonia umbellulata* (Mx.) Torr. White Clintonia. Abundant, East Pike Run, Salt Creek Twp., Hocking Co. Floyd Bartley and Leslie L. Pontius.
532. *Tradescantia pilosa* Lehm. Zigzag Spiderwort. Paint Creek Gorge, Ross Co. Floyd Bartley and Leslie L. Pontius. "Common in woodlands," Twin Twp., Preble Co. Lawrence E. Hicks.
542. *Juncus marginatus* Rostk. Grass-leaf Rush. Wayne Twp., Ashtabula Co. Lawrence E. Hicks.
544. *Juncus articulatus* L. Jointed Rush. Silver Lake, near New Carlisle, Clark Co. John H. Schaffner.
545. *Juncus torreyi* Cov. In pond near Columbus, Franklin Co. R. B. Gordon and H. F. Thut.
547. *Juncus brachycephalus* (Engelm.) Buch. Small-headed Rush. Liberty Twp., Highland Co. Katie M. Roads.
553. *Xyris flexuosa* Muhl. Slender Yellow-eyed-grass. Springfield Twp., Lucas Co. Louis W. Campbell.
558. *Iris cristata* Ait. Crested Dwarf Iris. Pure white form. East Pike Run, Hocking Co. Floyd Bartley.
556.3. *Iris virginica* L. Virginia Blue-flag. All of our Blue-flags, which have heretofore gone under the name of *Iris versicolor*, belong to this species, except one specimen. Generally distributed in the state in suitable habitats from Williams, Hamilton (Edgar Anderson) and Greene counties north-eastward to Cuyahoga (Edgar Anderson) and Perry. Conneaut R., Conneaut Twp., Ashtabula Co. L. E. Hicks.

557. *Iris versicolor* L. Northern Blue-flag. According to the study of Edgar Anderson, all of our Blue-flags, which have heretofore gone under the name of *Iris versicolor*, belong to the preceding number. This species probably only occurs in north-eastern Ohio. The only specimen in the herbarium is from Ashtabula county. Also new specimen from Conneaut R., Conneaut Twp., Ashtabula Co. L. E. Hicks.

ORDER SCITAMINALES.

Cannaceæ. Canna Family.

563.2. *Canna generalis* Bail. Common Canna. Spontaneous from seed; surviving only for the season. Columbus, Franklin Co. John H. Schaffner.

567. *Fissipes acaule* (Ait.) Small. Moccasin-flower. White's Gulch, Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

577. *Blephariglottis lacera* (Mx.) Farw. Ragged Fringed-orchis. Springfield Twp., Lucas Co. Louis W. Campbell.

580. *Blephariglottis peramoena* (Gr.) Rydb. Fringeless Purple Orchis. Pee Pee Twp., Pike Co., White's Gulch, Jackson Co., Higby Prairie, Ross Co. Floyd Bartley and Leslie L. Pontius.

582. *Isotria verticillata* (Willd.) Raf. Whorled Isotria. Ofer Hollow, Jackson Co. Floyd Bartley and Leslie L. Pontius. "Neotoma," Good Hope Twp., Hocking Co. E. S. Thomas.

585. *Limodorum tuberosum* L. Limodorum. Shawnee State Forest, Scioto Co. Roscoe Franks and Conrad Roth.

588. *Ibidium cernuum* (L.) House. Nodding Lady's-tresses. Liberty Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.

593. *Peramium pubescens* (Willd.) MacM. Downy Rattlesnake-plantain. Big Darby Creek, Franklin Co. E. S. Thomas.

594. *Malaxis unifolia* Mx. Green Addermouth. Rock Hill, Colerain Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.

596. *Liparis loeselii* (L.) Rich. Fen Twayblade. "In a swamp" near Hillsboro, Highland Co. Katie M. Roads. Cranberry Island, Buckeye Lake, Licking Co. Lawrence E. Hicks.

599. *Corallorrhiza corallorrhiza* (L.) Karst. Early Coral-root. Cantwell Cliffs, Hocking Co. Glenn W. Blaydes.

604. *Magnolia tripelata* L. Umbrella Magnolia. Byers Hollow, Saltcreek Twp., Hocking Co., also Byers Hollow, Eagle Twp., Vinton Co. Floyd Bartley and Leslie L. Pontius.

608. *Ranunculus micranthus* Nutt. Rock Crowfoot. "In two woods and along small stream." Liberty Twp., Highland Co. Katie M. Roads.

612. *Ranunculus bulbosus* L. Bulbous Buttercup. "Abundant in a lawn; introduced in grass seed." Hillsboro, Highland Co. Katie M. Roads.

626. *Nigella damascena* L. Love-in-a-mist. Escaped. Columbus, Franklin Co. Mrs. W. H. Camp.

634. *Anemone cylindrica* Gr. Long-fruited Anemone. Springfield Twp., Lucas Co. Louis W. Campbell.

648. *Isopyrum biternatum* (Raf.) T & G. False Rue-anemone. Williamsport, Ross Co. Leslie L. Pontius.

652. *Parnassia caroliniana* Mx. Carolina Grass-of-Parnassus. North Union Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.

657.1. *Berberis thunbergii* DC. Japansee Barberry. Escaped in swamp woods, Delaware, Delaware Co. G. W. Blaydes.

664. *Drosera intermedia* Hayne. Spatulate Sundew. Springfield Twp., Lucas Co. Also in Spencer Twp. Louis W. Campbell.

677. *Capnoides sempervirens* (L.) Borck. Pink Corydalis. Spencer Twp., Lucas Co. Louis W. Campbell. Green Twp., Ross Co. Floyd Bartley.

694. *Radicula hispida* (Desv.) Britt. Hispid Yellow-cress. Spencer Twp., Lucas Co. Louis W. Campbell.

700. *Lepidium draba* L. Hoary Peppergrass. Columbus, Franklin Co. C. J. Willard.

701.1. *Lepidium perfoliatum* L. Perfoliate Peppergrass. "In a small pasture lot," Hillsboro, Highland Co. Katie M. Roads.

703. *Thlaspi arvense* L. Field Penny-cress. Lucas Co. L. W. Campbell.
706. *Sophia pinnata* (Walt.) Howell. Pinnate Tansy-mustard. New Vienna, Clinton Co. Katie M. Roads.
708. *Cheirinia cheiranthoides* (L.) Link. Worm-seed Mustard. Amanda Twp., Fairfield Co. Floyd Bartley and Leslie L. Pontius.
708.1. *Cheirinia inconspicua* (Wats.) Britt. Prairie Cheirinia. From the west. Milford, Clermont Co. "Alluvial soil, cornfields." E. Lucy Braun.
709. *Cheirinia repanda* (L.) Link. Repand cheirinia. Washington Court House, Fayette Co. C. J. Willard.
716. *Arabidopsis thaliana* (L.) Britt. Mouse-ear Cress. Harrison Twp., Ross Co. Floyd Bartley.
753. *Cakile edentula* (Bigel.) Hook. Sea Rocket. Toledo, Lucas Co. R. T. Wareham.
754. *Polonisia graveolens* Raf. Clammy-weed. Little Cedar Point, Jerusalem Twp., Lucas Co. Louis W. Campbell; Toledo, Lucas Co. R. T. Wareham.
774.1. *Linum striatum* Walt. Ridged Flax. "Growing in a bog." Liberty Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
807. *Dicrophyllum marginatum* (Pursh) K. & G. Snow-on-the-mountain. A waif in Columbus, Franklin Co. John H. Schaffner. "A common escape in Twin Twp.," Preble Co. Lawrence E. Hicks.
812. *Chamaesyce polygonifolia* (L.) Small. Knotweed Spurge. Toledo, Lucas Co. R. T. Wareham.
814. *Callitriche austini* Engelm. Terrestrial Water-starwort. Rock House, Hocking Co., "Cabin Cove," Jackson Twp. Franklin Co. R. B. Gordon.
815. *Callitriche palustris* L. Vernal Water-starwort. Delaware, Delaware Co. Glenn W. Blaydes.
827. *Napaea dioica* L. Glade-mallow. Prospect, Marion Co. E. N. Transeau.
829. *Hibiscus moscheutos* L. Swamp Rose-mallow. Stage's Pond near Ashville, Pickaway Co. Flowers white to pink and also sulphur yellow. Lloyd M. Shupe, Liberty Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
830. *Hibiscus militaris* Cav. Halberd-leaf Rose-mallow. Prospect, Marion Co. E. N. Transeau. Calamus pond, Wayne Twp., Pickaway Co. Leslie L. Pontius and Floyd Bartley. Sims Creek, Village of Gallia, Gallia Co. W. H. Camp.
840. *Hypericum cistifolium* L. Round-podded St. John's-wort. North Union and Colerain Twps., Ross Co. Floyd Bartley and Leslie L. Pontius.
848. *Hypericum drummondii* (Grev. & Hook.) T. & G. Drummond's St. John's-wort. Near Barnesville, Belmont Co. Collected by Emma E. Laughlin. Huntington Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
849. *Sarothra gentianoides* L. Orange-grass. Springfield Twp., Lucas Co. Louis W. Campbell. Jackson, Jackson Co. W. G. Stover.
850. *Triadenum virginicum* (L.) Raf. Marsh St. John's-wort. Amanda Twp., Fairfield Co. Floyd Bartley and Leslie L. Pontius.
853.1. *Hudsonia tomentosa* Nutt. Woolly Hudsonia. "A few plants growing in a sandy area near the Indiana-Ohio boundary line." Southwest of Montpelier, Williams Co. Lawrence E. Hicks.
874. *Viola lanceolata* L. Lanceleaf Violet. Springfield Twp., Lucas Co. Louis W. Campbell.
884. *Viola sagittata* Ait. Arrowleaf Violet. Cantwell Cliff, Hocking Co. Floyd Bartley.
908. *Lychnis alba* Mill. White Lychnis. Clinton Twp., Franklin Co. and Shelby, Richland Co. R. A. Wareham. Also Columbus, Franklin Co. L. E. Hicks.
912. *Silene latifolia* (Mill.) Britt. & Rendle. Bladder Campion. Kellogsville, Ashtabula Co. Lawrence E. Hicks.
920.1. *Silene wherryi* Small. Wherry's Catchfly. Mifflin Twp., (1⅓ mi. east of Sinking Spring), Pike Co. E. T. Wherry. Transfer the record of Silene caroliniana Walt. from Fort Hill, Highland Co., collected by Katie M. Roads in 1925 to this new species also. Along with other characters this new species can be distinguished from Silene caroliniana by its calyx

equaling the petal claws and being densely covered with pilose nonglandular hairs and by the style which is about as long as the ovulary.

923. *Vacaria vacaria* (L.) Britt. Cowherb. Benton Twp., Ottawa Co. Louis W. Campbell.

925. *Dianthus armeria* L. Deftford Pink. Howard, Knox Co. Lawrence E. Hicks.

933. *Allionia nyctaginea* Mx. Heart-leaf Umbrella-wort. Toboso, Licking Co. John H. Schaffner.

952. *Chenopodium leptophyllum* (Moq.) Nutt. Narrowleaf Goosefoot. Hillsboro, Highland Co. Katie M. Roads.

976. *Pleuropterus zuccarinii* Small. Japanese Knotweed. "Found in two localities near Camden, Preble Co." Lawrence E. Hicks.

980. *Tracaulon arifolium* (L.) Raf. Halberd-leaf. Tear-thum. Liberty Twp., Ross Co. Leslie L. Pontius and Floyd Bartley.

992. *Persicaria orientalis* (L.) Spach. Prince's-feather. Gratis, Preble Co. Lawrence E. Hicks.

1006. *Dasiphora fruticosa* (L.) Rydb. Shrubby Cinquefoil. North Union Twp., Ross Co. Floyd Bartley and Leslie L. Pontius. Silver Lake, near New Carlisle, Clark Co. John H. Schaffner.

1009. *Potentilla recta* L. Upright Cinquefoil. West of Chillicothe, Ross Co. Floyd Bartley and Leslie L. Pontius.

1030. *Rubus odoratus* L. Rose-flowered Raspberry. Paint Creek Gorge. Ross Co. Floyd Bartley and Leslie L. Pontius.

1034. *Filipendula rubra* (Hill.) Rob. Queen-of-the-prairie. North Union Twp., Ross Co. Floyd Bartley and Leslie L. Pontius. Bushville, Ashtabula Co. Lawrence E. Hicks.

1034.1. *Filipendula ulmaria* (L.) Maxim. Meadow-queen. From Europe. "Escaped from cultivation along roadside near Kellogsville, Ashtabula Co." Lawrence E. Hicks.

1104. *Baptisia leucantha* T. & G. Large White False-indigo. Madison Twp., Fairfield Co. E. S. Thomas, L. E. Hicks, and C. F. Walker.

1106. *Lupinus perennis* L. Wild Lupine. Springfield Twp., Lucas Co. Louis W. Campbell.

1112. *Trifolium agrarium* L. Yellow Hop Clover. Scioto Furnace, Scioto Co. Conrad Roth.

1113. *Trifolium procumbens* L. Low Hop Clover. Hillsboro, Highland Co. Katie M. Roads. Also "Swamp woods," Delaware, Delaware Co. G. W. Blaydes.

1116. *Trifolium arvense* L. Rabbit-foot Clover. Hillsboro, Highland Co. Katie M. Roads.

1118. *Trifolium reflexum* L. Buffalo Clover. On "Devil's Back Bone," Washington Twp., Pickaway Co. Leslie L. Pontius.

1157. *Lespedeza virginica* (L.) Britt. Slender Bush-clover. Colerain Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.

1161.1. *Vicia villosa* Roth. Hairy Vetch. Hillsboro, Highland Co. Katie M. Roads.

1166. *Vicia sativa* L. Common Vetch. Hillsboro, Highland Co. Katie M. Roads.

1170. *Lathyrus palustris* L. Marsh Pea. Prairie Twp., Franklin Co. R. B. Gordon.

1173.1. *Lathyrus latifolius* L. Everlasting Pea. "Along railroad near Geneva," Ashtabula Co. Lawrence E. Hicks.

1187. *Micranthes pennsylvanica* (L.) Haw. Pennsylvania Saxifrage. Delaware, Delaware Co. Glenn W. Bladyes. Liberty Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.

1189. *Sullivantia sullivantii* (T. & G.) Britt. Sullivantia. Near Byington, Mifflin Twp., Pike Co. Reported by E. S. Thomas.

1190. *Tiarella cordifolia* L. False Mitrewort. East Pike Run, Hocking Co. Floyd Bartley. Also Mechanicsburg, Champaign Co. Chas. B. Wing.

1201. *Dirca palustris* L. Leatherwood. Growing with Arbor vitae at Cedar Falls, Adams Co. E. F. McCarthy and R. B. Gordon.

1204. *Rhamnus lanceolata* Pursh. Lanceleaf Buckthorn. Greer, Knox Co. R. B. Gordon. Springfield Twp., Ross Co. Floyd Bartley.

1207. *Ceanothus americanus* L. Common New Jersey Tea. Springfield Twp., Lucas Co. Louis W. Campbell.

1214. *Ampelopsis cordata* Mx. Heartleaf Ampelopsis. Crown City, Gallia Co. W. H. Camp.

1219. *Euonymus americanus* L. American Strawberry-bush. White's Gulch, Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

1239. *Toxicodendron vernix* (L.) Ktz. Poison Sumac. Cedar Swamp, Champaign Co. Glenn W. Blaydes. Liberty Twp., Ross Co.; Amanda Twp., Fairfield Co. Floyd Bartley and Leslie L. Pontius. "In swamp along Kokosing R., 2 miles north of Frederictown," Knox Co. Lawrence E. Hicks.

1254. *Cannabis sativa* L. Hemp. "Common for about a mile in pasture fields along Twin Creek," Lanier Twp., Preble Co. Lawrence E. Hicks.

1285.1. *Alnus alnus* (L.) Britt. European Alder. "Escaped from cultivation along stream; trees of various size." Minerva Park, Franklin Co. R. B. Gordon and F. M. Chapman.

1324. *Philadelphus coronarius* L. Garden Mock-orange. Hillsboro, Highland Co. Katie M. Roads.

1338. *Epilobium lineare* Muhl. Linear-leaf Willow-herb. Liberty Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.

1348. *Hartmannia speciosa* (Nutt.) Small. White Evening-primrose. St. Marys, Auglaize County. Wm. Kayser. Accidental in Columbus, Franklin Co. Glenn W. Blaydes.

1358 a. *Cucurbita pepo ovifera* Bail. Yellow-flowered Gourd. "A large number of plants found growing along west bank of Twin Creek, 2 mi. south of West Alexandria," Preble Co. Lawrence E. Hicks.

1399. *Chamaedaphne calyculata* (L.) Moench. Leather-leaf. "In small Sphagnum bog Nesmith Lake, Summit Co. East of Richmond Center, Ashtabula Co. Lawrence E. Hicks.

1401. *Oxydendrum arboreum* (L.) DC. Sorrel-tree. Paint Creek Gorge, Ross Co. Floyd Bartley and Leslie L. Pontius.

1402. *Epigaea repens* L. Trailing Arbutus. Harrison Twp., Ross Co. Floyd Bartley.

1403. *Gaultheria procumbens* L. Creeping Wintergreen. Harrison Twp., Ross Co. Floyd Bartley.

1410. *Vaccinium atrococcum* (Gr.) Heller. Dark Blueberry. "In bog, terminal moraine." Beach City, Sugar Creek Twp., Stark Co. W. H. Camp.

1415.2. *Halesia carolina* L. Silver-bell. Porter Twp., Scioto Co. Conrad Roth.

1418. *Phlox ovata* L. Mountain Phlox. Springfield Twp., Lucas Co. Louis W. Campbell.

1422. *Phlox stolonifera* Sims. Creeping Phlox. Ofer Falls, Coal Twp., Jackson County. Floyd Bartley.

1423. *Phlox subulata* L. Mr. Edgar T. Wherry studied our species of Phlox in April and has recently published a revision of this species dividing our material into two new varieties as given below. See Bartonia *11:* 27, 1929. It would now be interesting to find the line across the state which separates the two varieties or regions in which the two might overlap.

1423.a. *Phlox subulata ciliata* Wherry. N. Var. Northern Ground Phlox. Defiance, Knox, Medina, Lorain, Cuyahoga, Portage, Lake.

1423.b. *Phlox subulata australis* Wherry. N. Var. Southern Ground Phlox. Harlem, Delaware Co. (E. T. Wherry), Franklin, Licking, Muskingum, Guernsey, Fairfield; Sinking Springs, Highland Co. (E. T. Wherry); Adams, Scioto, Lawrence.

1468. *Gentiana andrewsii* Griseb. Closed Gentian. Along Sims Creek, Village of Gallia, Gallia Co. W. H. Camp. More than 100 white-flowered specimens with no blue ones anywhere nearby. Jerusalem Twp., Lucas Co. Louis W. Campbell.

1472. *Obolaria virginica* L. Pennywort. Harrison Twp., Ross Co. Floyd Bartley.

1473. *Bartonia virginica* (L.) B. S. P. Yellow Bartonia. Higby Prairie, Ross Co. Floyd Bartley and Leslie L. Pontius.

1479. *Apocynum pubescens* R. Br. Velvet Dogbane. "On dry sandy hill," Beach City, Sugar Creek Twp., Stark Co. W. H. Camp.

1487. *Asclepias sullivantii* Engelm. Sullivant's Milkweed. Darby Twp., Pickaway Co. "Also seen in Fayette Co., two localities between Mt. Sterling and Washington Court House." E. S. Thomas and R. B. Gordon.
1493. *Asclepias verticillata* L. Whorled Milkweed. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.
1515. *Solanum rostratum* Dunal. Columbus, Franklin Co. A rare weed. John H. Schaffner.
1517.1. *Verbascum phlomoides* L. Clasping-leaf Mullen. Hamilton, Butler Co. From Europe. Mrs. Lulu Brand. (Braun Herbarium).
1521 a. *Chelone glabra linifolia* Coleman. Reported with half-tone habitat illustration from near Whitehouse, Lucas Co. in Bartonia, 1927-1928, p. 23. by F. W. Pennell and E. T. Wherry.
1529. *Conobea multifida* (Mx.) Benth. Conobea. On limestone. "The Point," Paint Twp., Ross Co. E. S. Thomas and R. B. Gordon. Also north Union Twp. and Springfield Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
1535. *Veronica anagallis-aquatica* L. Water Speedwell. North Union Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
1552. *Aureolaria pedicularia* (L.) Benth. Fernleaf False Foxglove. Springfield Twp., Lucas Co. Louis W. Campbell.
1555. *Aureolaria flava* (L.) Farw. Smooth False Foxglove. Springfield Twp., Lucas Co. Louis W. Campbell.

According to F. W. Pennell's treatment our species of Agalinis are as follows:

1556. *Agalinis purpurea* (L.) Pennell. Large Purple Agalinis. Rather General.
1557. *Agalinis paupercula* (Gr.) Britt. Small Purple Agalinis. Erie, Ottawa, Lucas.
1558. *Agalinis tenuifolia* (Vahl.) Raf. Slender Agalinis. Lucas, Erie (Moseley), Fulton (Pennell), Stark, Wayne, Washington, Licking, Fairfield, Gallia, Adams.
1558a. *Agalinis tenuifolia macrophylla* (Benth.) Blake. Auglaize, Fulton, Lucas, Erie (Pennell), Ottawa (Pennell), Wood, Monroe, Mahoning (Pennell), Belmont, Franklin, Madison, Fairfield (Pennell), Champaign (Pennell), Hocking, Clark, Greene, Clermont, Montgomery, Miami, Hamilton (Pennell).
1558b. *Agalinis tenuifolia parviflora* (Nutt.) Pennell. Erie Co. (Pennell).
1559. *Agalinis skinneriana* (Wood) Britt. Skinner's Agalinis. Wood Co.
1561. *Castilleja coccinea* (L.) Spreng. Scarlet Painted-cup. "Very plentiful at place where found; several acres covered with it." On state route 56, between Ash Cave and Hue, Benton Twp., Hocking Co. E. A. Albaugh. Ash Cave, Hocking Co. Kenneth Wright. Greer, Knox Co. R. B. Gordon. Springfield Twp., Lucas Co. Louis W. Campbell.
1579.1. *Catalpa ovata* Don. Japanese Catalpa. Head of Pine Run, Ashland Co. Several trees apparently growing wild among white pines in stream bottom." Lawrence E. Hicks.
1583. *Utricularia intermedia* Hayne. Flatleaf Bladderwort. Cedar Swamp, Champaign Co. Lawrence E. Hicks and Edward S. Thomas.
1598. *Myosotis virginica* (L.) B. S. P. Virginia Forget-me-not. Greer, Knox Co. R. B. Gordon.
1598.1. *Anchusa azurea* Mill. (*A. italica* Retz.). Azure Anchusa. Escaped in woods. From Europe. Wapakoneta, Auglaize Co. Wm. Kayser.
1607. *Echium vulgare* L. Blueweed. Conneaut, Ashtabula Co. Lawrence E. Hicks.
1616. *Trichostema dichotomum* L. Blue-curls. Flint Ridge, Hopewell Twp., Licking Co. Abundant in abandoned field. John H. Schaffner.
1627. *Scutellaria integrifolia* L. Hyssop Skullcap. Queer Creek, Hocking Co. Floyd Bartley and Leslie L. Pontius.
1638. *Clinopodium glabrum* (Nutt.) Ktz. Low Calamint. "Abundant on limestone." "The Point," Paint Twp., Ross Co. E. S. Thomas and R. B. Gordon.
1661. *Perilla frutescens* (L.) Britt. Perilla. "Abundant escape in many sections of Twin Twp.," Preble Co. Lawrence E. Hicks.

1663.1. *Meehania cordata* (Nutt.) Britt. Meehania. Blue Creek, Hocking Co. Floyd Bartley. Abundant near Ash Cave, Hocking Co. Lawrence E. Hicks and E. S. Thomas.
1672. *Lamium purpureum* L. Red Henbit. Concord Twp., Delaware Co. John H. Schaffner.
1696. *Plantago virginica* L. Dwarf Plantain. Gibsonville, Hocking Co. Chas. Ziegler. "Neotoma," Good Hope Twp., Hocking Co. E. S. Thomas.
1698. *Aralia spinosa* L. Angelica-tree. Twin Twp., Preble Co.; also in Lanier Twp. "Several thickets in western Monroe Twp.," Ashtabula Co. Lawrence E. Hicks.
1700. *Aralia nudicaulis* L. Wild Sarsaparilla. Springfield Twp., Ross Co., also in Harrison Twp., Ross Co. Floyd Bartley.
1704. *Eryngium aquaticum* L. Rattlesnake Master. Lynx P. O., Adams Co. Arthur R. Harper. Big Island Twp., Marion Co. E. N. Transeau. Monclova Twp., Lucas Co. L. W. Campbell and M. R. Van Cleve. Also Lucas Co. R. A. Schaller.
1752. *Houstonia purpurea* L. Large Houstonia. Paint Creek Gorge, Ross Co. Floyd Bartley and Leslie L. Pontius.
1753. *Houstonia ciliolata* Torr. Fringed Houstonia. Harrison and Springfield Twps., Ross Co. Floyd Bartley.
1760. *Diodia teres* Walt. Rough Buttonweed. Toad Heaven Hollow, Jackson Co. Floyd Bartley and Leslie L. Pontius.
1760.1. *Galium verum* L. Yellow Bedstraw. Circleville Twp., Pickaway Co. Floyd Bartley.
1766. *Galium mollugo* L. White Bedstraw. Jackson Twp., Pickaway Co. Floyd Bartley.
1777. *Viburnum dentatum* L. Toothed Arrow-wood. "Dry prairie on a steep clay bank." Big Darby Creek, Franklin Co. Edward S. Thomas. Also near Walhonding, Coshocton Co. C. F. Walker.
1779. *Viburnum cassinoides* L. Withe-rod. Ofer Hollow, Jackson Co. Leslie L. Pontius and Floyd Bartley.
1786.1. *Triosteum aurantiacum* Bickn. Scarlet-fruited Horse-gentian. Liberty Twp., Highland Co. Katie M. Roads.
1799. *Lonicera sullivantii* Gr. Sullivant's Honeysuckle. River Drive, Delaware, Delaware Co. Glenn W. Blaydes.
1802. *Diervilla diervilla* (L.) MacM. Brush-honeysuckle. Abundant. Colerain Tp., Ross Co. Floyd Bartley and Leslie L. Pontius. Walhonding, Coshocton Co. Lawrence E. Hicks.
1812. *Campanula rotundifolia* L. Harebell. "On limestone at 'The Point,' where Paint Creek joins the preglacial channel." Paint Twp., Ross Co. E. S. Thomas and R. B. Gordon.
1835. *Rudbeckia speciosa* Wend. Showy cone-flower. Wayne and Washington Twps., Pickaway Co.; Colerain Twp., Ross Co. Leslie L. Pontius and Floyd Bartley.

Revised List of the Species of Helianthus.

1840. *Helianthus occidentalis* Ridd. Fewleaf Sunflower. Fulton, Erie, Franklin, Adams.
1841. *Helianthus microcephalus* T. & G. Small Wood Sunflower. Cuyahoga, Jackson.
1841.1. *Helianthus glaucus* Small. Glaucous Sunflower. Belmont, Lake, Cuyahoga, Wayne, Richland, Fairfield, Ross, Miami, Montgomery, Hamilton.
1842. *Helianthus giganteus* L. Giant Sunflower. From Ottawa, Wayne, and Fairfield counties westward.
1842.1. *Helianthus altissimus* L. Tall Sunflower. Williams County.
1843. *Helianthus maximiliani* Schrad. Maximilian's Sunflower. Lake, Franklin, Champaign, Hamilton, Auglaize Co. (Wm. Kayser). From the West.
1843.1. *Helianthus dalyi* Britt. Daly's Sunflower. Huron county (Schaffner).
1844. *Helianthus grosse-serratus* Mart. Sawtooth Sunflower. Erie, Wood, Huron, Franklin, Madison.
1844.1. *Helianthus instabilis* Wats. Unstable Sunflower. Auglaize, Cuyahoga, Madison, Clark.

1845. *Helianthus kellermani* Britt. Kellerman's Sunflower. Franklin County (Kellerman).
1846. *Helianthus divaricatus* L. Woodland Sunflower. Rather general.
1847. *Helianthus mollis* Lam. Hairy Sunflower. Lake, Erie, Franklin.
1848. *Helianthus doronicoides* Lam. Oblong-leaf Sunflower. Erie (Moseley), Franklin (Sullivant).
1849. *Helianthus decapetalus* L. Thinleaf Sunflower. General.
1850. *Helianthus tracheliifolius* Mill. Throatwort Sunflower. No specimens.
1850.1. *Helianthus brevifolius* Wats. Short-leaf Sunflower. Richmond, Lake County (Otto Hacker). Type. Painesville, Lake County (Hacker). Co-type.
1851. *Helianthus strumosus* L. Paleleaf Wood Sunflower. Madison, Defiance, Ottawa, Cuyahoga.
1852. *Helianthus hirsutus* Raf. Hirsute Sunflower. General.
1853. *Helianthus laetiflorus* Pers. Showy Sunflower. No specimens.
1854. *Helianthus tuberosus* L. Jerusalem Artichoke. General.
1855. *Helianthus annuus* L. Common Sunflower. General.
1856. *Helianthus petiolaris* Nutt. Prairie Sunflower. Lake, Huron, Belmont, Franklin Co. (Glenn W. Blaydes).
1859. *Coreopsis lanceolata* L. Lance-leaf Tickseed. Wapakoneta, Auglaize Co. Wm. Kayser.
1862. *Coreopsis verticillata* L. Whorled Tickseed. Silver Lake, near New Carlisle, Clark Co. John H. Schaffner.
1901. *Grindelia squarrosa* (Pursh.) Dun. Broad-leaf Gum-plant. Marysville, Union Co. Chas. Alspach.
1904. *Solidago squarrosa* Muhl. Stout Goldenrod. Rock Hill, Colerain Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
1908. *Solidago hispida* Muhl. Hairy Goldenrod. Rock Hill, Colerain Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
1909. *Solidago erecta* Pursh. Slender Goldenrod. Rock Hill, Colerain Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
1910. *Solidago uliginosa* Nutt. Bog Goldenrod. Colerain Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
1923. *Solidago ohioensis* Ridd. Ohio Goldenrod. Ira May Swamp, Wayne Twp., Pickaway Co.; North Union Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
1924. *Solidago riddellii* Frank. Riddell's Goldenrod. Ira May Swamp, Wayne Twp., Pickaway Co. Floyd Bartley and Leslie L. Pontius.
1930. *Sericocarpus linifolius* (L.) B. S. P. Narrow-leaf Whitetop Aster. Shawnee State Forest, Scioto Co. Conrad Roth.
1942. *Aster phlogifolius* Muhl. Thinleaf Purple Aster. Rock Hill, Colerain Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
1982. *Lacinaria scariosa* (L.) Hill. Large Blazing Star. "Red Hills Region," Central College, Franklin Co. R. B. Gordon and F. B. Chapman.
1983. *Lacinaria spicata* (L.) Ktz. Dense Blazing-star. North Union Twp., Ross Co.; Kibler's Bog, Circleville Twp., Pickaway Co. Floyd Bartley and Leslie L. Pontius.
1988. *Elephantopus carolinianus* Willd. Carolina Elephant's-foot. Crown City, Gallia Co. W. H. Camp.
1991. *Anthemis arvensis* L. Field Dog-fennel. Wapakoneta, Auglaize Co. Wm. Kayser.
1997. *Matricaria inodora* L. Scentless Camomile. "Several plants along railroad." Hillsboro, Highland Co. Katie M. Roads.
2006.1. *Artemisia absinthium* L. Common Wormwood. "Common escape in some sections of Twin Twp., Preble Co." From Europe. Lawrence E. Hicks.
2008. *Mesadenia reniformis* (Muhl.) Raf. Great Indian-plantain. Paint Creek Gorge, Ross Co. Floyd Bartley and Leslie L. Pontius. Also Mineral Springs, Adams Co. Specimen collected by W. A. Kellerman.
2010. *Mesadenia tuberosa* (Nutt.) Britt. North Union Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
2011. *Synosma suaveolens* (L.) Raf. Sweet-scented Indian-plantain. Wayne Twp., Pickaway Co. Leslie L. Pontius and Floyd Bartley.

2016. *Tussilago farfara* L. Coltsfoot. "A patch about five feet across, by the side of a road." Milan, Erie Co. S. Hawley. Ashtabula, Ashtabula Co. Also along Conneaut R. 6 miles from mouth. L. E. Hicks.
2023. *Cirsium virginianum* (L.) Mx. Virginia Thistle. Big Darby Creek, Franklin Co. E. S. Thomas.
2029.1. *Centaurea vochinensis* Bernh. Tyrol Star-thistle. Cantwell Cliffs, Hocking Co. Glenn W. Blaydes.
2029.2. *Centaurea nigra* L. Black Star-thistle. Beach City, Sugar Creek Twp., Stark Co. W. H. Camp.
2039.1. *Sonchus uliginosus* Bieb. Glandless Field Sow-thistle. Washington Twp., Pickaway Co. Leslie L. Pontius and Floyd Bartley.
2043. *Lactuca saligna* L. Willow Lettuce. Washington Twp., Pickaway Co. Leslie L. Pontius and Floyd Bartley.
2058. *Hieracium gronovii* L. Gronovius' Hawkweed. Springfield Twp., Lucas Co. Louis W. Campbell.

THE ALIMENTARY CANAL OF *PHYLLOPHAGA GRACILIS* BURM.*†

FRED WALKER FLETCHER.

Introduction.

The following study is a direct result of interest developed in a course of entomology given by Dr. C. H. Kennedy, on "Morphology and Development of Insects."

The material used in this work was collected in anticipation of such a study while the author was employed temporarily at the Asiatic Beetle Laboratory, at Westbury, Long Island, New York. The choice of *Phyllophaga gracilis*, Burm. for this problem was due to availability of specimens taken at a trap-light. This particular species is about one-half inch in length, elongate oblong in shape and pale brown in color. In the summer these beetles are found in Eastern Canada, Eastern and Southern United States, even extending as far west as Texas (5)‡. A considerable number of specimens was fixed in Kahle's solution after which they were transferred to and preserved in 70% alcohol.

The author acknowledges the helpful suggestions and criticisms of Dr. C. H. Kennedy under whose direction this study was made.

Gross Anatomy of the Digestive System.

General discussion.

The alimentary canal is one and one-half times longer than the body, in correlation with the phytophagus habits of this beetle. Morphologically the alimentary canal is divisible into three primary regions according to their embryonic origin. The fore-intestine (Stomodaeum) arises as an anterior ectodermal invagination; the hind-intestine (Proctodaeum) arises as a similar posterior invagination; the mid-intestine (Mesenteron or Ventriculus) which connects the two, develops as an endodermal sac from a proliferation of rings of endodermal cells, one around the posterior end of the fore-intestine and the other around

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‡Numbers in parentheses refer to literature cited in bibliography at end of paper.

the anterior end of the hind-intestine (2). These primary regions with their differentiations may be tabulated as follows: (Fig. 1, Plate I).

Fore-intestine.
1. Pharynx.
2. Oesophagus.
3. Crop.
4. Oesophageal valve.

Mid-intestine.
1. Stomach.

Hind-intestine.
1. Pyloric valve.
2. Malpighian tubules.
3. Proximal ileun.
4. Distal ileun.
5. Colon.
6. Rectum.

GROSS STRUCTURES OF FORE-INTESTINE.

The fore-intestine is a rather short, slender tube which comprises a little over one-eighth of the total length of the entire canal. It extends from the mouth back to the beginning of the mesothorax.

The *pharynx*, the initial region of the alimentary canal just posterior to the mouth, is evident as a slight dilation of the tract in the head.

The *oesophagus* is a short narrow tube connecting the pharynx to the crop, lying in the most anterior part of the prothorax. The only essential difference between this region and the two it connects is size, the oesophagus being smallest. Like the pharynx, it has apparently no function other than conduction.

The *crop* is present as a dilation of the hinder portion of the oesophagus, but not being large and conspicuous in this insect, it is doubtful whether it functions as a food reservoir, as does a true crop. This portion of the canal lies entirely in the posterior part of the prothorax.

The *oesophagal valve* marks the separation between the fore- and mid-intestine by a constriction. This constriction may be found at the divison between the pro and mesothorax; functionally this valve serves to prevent regurgitation.

GROSS STRUCTURE OF MID-INTESTINE.

The stomach or mid-intestine comprises a little more than half the total length of the alimentary canal in this species of insect. It extends as a straight tube, nearly uniform in diameter, to the beginning of the abdomen where it curves a little to the left and then continues to the fourth abdominal segment. Here it curves abruptly to the right and extends back to the second abdominal segment. At this point it turns caudad and in the third abdominal segment makes a complete loop which lies underneath the preceding portion and terminates very abruptly at the pyloric valve.

Fundamentally the ventriculus has the power of secretion and of absorption.

GROSS STRUCTURES OF THE HIND-INTESTINE.

The hind-intestine occupies a little more than a fourth of the total length of the tract and is clearly differentiated into its various parts.

The *pyloric-valve*, located at the union of the mid-intestine with the hind-intestine, serves to close the posterior end of the stomach. It is recognizable as a slight constriction just antecedent to the Malpighian tubules.

The *Malpighian tubules* are attached to the canal just posterior to the pyloric valve and are four in number. Two of these tubules arise from a common opening, while the other two arise separately.

The *proximal ileum* is comparatively short and appears much the same as the mid-intestine. This portion of the canal is posterior to the Malpighian tubules and lies in the fourth abdominal segment.

The *distal ileum* is much the larger of the two parts of the ileum. In general outline it resembles a mammalian stomach and is the most conspicuous region of the hind-intestine. Its anterior margin is well defined as it arises abruptly from a constriction in the proximal ileum. Its caudal margin is likewise definitely narrowed where it joins the colon. The distal ileum normally lies in the body with the anterior end more caudad than the posterior one. As this region of the tract leaves the proximal ileum, it turns abruptly to the left and extends forward with the posterior end resting on the coiled part of the ventriculus. The wall of the distal ileum is quite transparent and internal papillate processes are visible from the exterior. Most of this part of the canal lies in the third and fourth abdominal segments. Its function is obscure.

The *colon* is a small tube linking the distal ileum with the rectum. As it arises from the distal ileum it takes a rather irregular path back to the rectum, with which it merges gradually. The colon is uniform in diameter throughout. Its function is mainly conduction.

The *rectum* is just an enlargement of the colon and lies in the fifth and sixth segments of the abdomen. Both circular and longitudinal muscles are evident on its surface. Like the colon its function is conduction.

Histological Structure of the Alimentary Canal.

HISTOLOGICAL STRUCTURE OF THE FORE-INTESTINE.

Histologically the fore-intestine reveals a similarity of make-up throughout its various parts. On examination the following tissues from within outwards can be demonstrated in its wall: (1) Intima of cuticula of chitin; (2) Epithelium of hypodermal cells; (3) Longitudinal muscles; (4) Circular muscles, and (5) "Peritoneal membrane" of connective tissue cells.

The innermost layer is the cuticula of chitin which is homologous with the cuticula of the body wall and is secreted by the hypodermal epithelium. This intima forms a rather thin, non-cellular, almost transparent layer which lines the entire fore-intestine (Figs. 2, 4 and 5, Plate I). In the region of the pharynx, however, it is thicker than in the other parts, being covered with small chitinous spines which project more or less caudad (Fig. 2, Plate I).

The epithelium of hypodermal cells which form the layer of tissue just outside the intima is composed of flattened irregular cells. Their cell-walls are usually quite evident although a basement membrane was not visible.

Immediately outside the epithelium may be found isolated bundles of longitudinal muscle tissue. A cross-section of the fore-intestine

demonstrates three such groups of muscles situated at the bases of folds in the epithelium.

Surrounding the longitudinal muscle layer is a more conspicuous layer of circular muscles, especially so around the anterior part of the pharynx and around the oesophagus. Elsewhere along the fore-intestine these muscles appear as scattered strands.

The outermost part of the fore-intestine has traces of connective tissue known as "peritoneal membrane." This consists of apparently structureless tissue in which an occasional nucleus makes its appearance.

At the point of junction of the fore- and hind-intestine, there is an *oesophageal valve* (Fig. 4, Plate I). This structure is formed by the wall of the fore-intestine being prolonged into the lumen of the mid-intestine. This projection of the fore-intestine then becomes reflected upon itself and passing forward unites with the stomach wall, (2). At this point the intima of the fore-intestine disappears. The epithelial cells of the inner part of this fold are much the same as those of the crop, being flattened and more or less irregular in shape.

The epithelial cells of the reflected area in the valve are much larger than those just mentioned and assume the shape of columnar epithelium.

The depression formed by the extension of the fore-intestine into the mid-intestine is filled with circular muscles. These are very numerous and serve to close the valve.

Just outside these muscles are ten or twelve strands of longitudinal muscles which extend from the epithelium of the fore-intestine across to the epithelium of the mid-intestine. Scattered between both ends of these muscles may be found numerous circular muscles. At this point the longitudinal and circular muscles reverse their positions in respect to each other, i.e. at the point where the mid-intestine originates, the longitudinal muscles shift to the outside of the circular muscles. The reverse is true in the fore-intestine. (See Fig. 4.)

The "peritoneal membrane" is present in this region.

HISTOLOGICAL STRUCTURES OF THE MID-INTESTINE.

The mid-intestine in *Phyllophaga gracilis* is an elongate tube which is marked anteriorly by the oesophageal valve, and posteriorly by the pyloric valve. This section of the canal is quite uniform in shape throughout, except that the posterior half is thrown into folds.

The structure of the mid-intestine is markedly different from that of the fore-intestine. In the ventriculus there is no intima, the relative positions of the circular and longitudinal muscles being reversed.

Histological examination of the stomach gives the following sequence of tissues: (1) epithelium of endoderm cells supported by a basement membrane. (2) circular muscles. (3) longitudinal muscles, and (4) "peritoneal membrane" of connective tissue. (Figs. 6 and 7, Plate I).

The cells of the entire epithelium vary greatly at times in size and shape; they may be almost cuboidal after a period of secretion; or they may be decidedly columnar during the resting stage, depending upon their physiological condition.

Secretion seems to be of the holocrine type, where the entire contents of the cell bursts out into the lumen of the intestine, after which the cell is replaced by new cells. In this particular insect these cells seem to be replaced either from nidi, (nests of embryonic tissue that lie below the epithelium) or from small replacement cells that rest on the basement membrane at the base of the epithelium. These cell nests are rather peculiar in that they lie completely below the epithelium, their definite relationship to digestion being as yet obscure. Further study may possibly reveal a condition similar to that found by Lewis in *Passalus cornutus*. The replacement cells already referred to are recognizable as small triangular shaped cells at the base of the epithelial layer. They present a varying degree of sizes, and in some sections, their function of replacement can hardly be doubted. It is hoped that further study will throw some light on these problems.

Surrounding these nidi and just outside the basement membrane may be found the circular muscle layer. This layer usually forms a rather conspicuous and continuous ring of tissue around the canal as viewed from a cross-section. (Fig. 6, Plate I). These muscle fibers are more or less interlaced at their ends.

Immediately outside the circular muscle layer are isolated strands of longitudinal muscles that are not nearly so abundant as the circular muscles.

A rather conspicuous amount of connective tissue is present in both the cross and longitudinal sections. (Fig. 7, Plate I).

HISTOLOGICAL STRUCTURES OF HIND-INTESTINE.

The hind-intestine which comprises a little more than one-fourth the total length of the alimentary tract, is differentiated considerably in its several parts. Anteriorly it is marked by the pyloric valve and posteriorly by the anus. Histologically this division of the canal presents from within outwards the following tissues: (1) intima; (2) Hypodermal epithelium resting on a basement membrane; (3) Circular muscles; (4) Longitudinal muscles, and (5) Connective tissue.

The *pyloric valve* represents the anterior limit of the hind-intestine. (Fig. 8, Plate II). The mid-intestine terminates abruptly and along the posterior margin of the columnar epithelium there is a row of small cuboidal cells. Immediately below this point of the tract there arises a ring of greatly elongated cells which extend down into the hind-intestine. This group of hypodermal cells is known as the pyloric valve.

The inner margin of the valve is lined with intima and makes its origin at the point of division between the mid- and hind-intestine.

The epithelium of the valve is bounded on the outside by well-developed circular muscles which function in closing the valve.

The basement membrane is indistinct.

The *Malpighian tubules* arise as invaginations of the hind-intestine just posterior to the pyloric valve. (Fig. 8, Plate II). The epithelial cells at origin of the tubules are rather narrow and elongate but they soon assume their characteristic cuboidal shape. The nuclei throughout the tubules are quite large ovate structures. Cross sections of the tubules show a decided difference in their sizes; number of epithelial

cells in such sections varying from five to fourteen or fifteen. (Figs. 9, 10 and 11, Plate II).

At the mouth of these tubules and extending into them for a short distance is a very delicate layer of intima. Elsewhere in them they are lined with a striated border. In some sections however this striated border is indistinct.

On the outside the Malpighian tubules are bounded by a narrow layer of connective tissue.

The *ileum* is the intial portion of the hind-intestine. It is bounded on the anterior side by the pyloric valve and on the posterior margin by the colon. In gross structure and histological make-up the ileum is divided into a proximal and distal region.

The *proximal division* of the ileum is shorter and narrower than the distal ileum and very thin walled. (Fig. 3, Plate I). The anterior margin gives rise to the Malpighian tubules which the posterior one is constricted where it joins the distal part of the ileum.

Internally the proximal ileum is lined with a very delicate layer of intima. Outside this layer of chitin is a layer of epithelium composed of very irregular cells which possess rather large ovoid nuclei. This layer of cells is thrown into numerous folds at each extremity of this portion of the ileum. The basement membrane is not visible.

The circular muscle layer is quite prominent and usually composed of two or three thin strands of muscle tissue.

Along the outside of this layer are scattered numerous isolated strands of longitudinal muscle tissue.

"Peritoneum" is also evident in some sections.

The *distal ileum* of *Phyllophaga gracilis* is without a doubt the most outstanding structure in the whole alimentary canal. It is unusual, both in its gross and histological anatomy. In size it is much larger than the proximal ileum, being over four times as long and twice as wide. The anterior margin of the distal ileum arises from a constriction at the posterior end of the proximal ileum. It at once expands to its normal size, having a diameter greater than that of any other part of the canal. Its caudal end narrows quite abruptly as it joins the colon but no indication of a valve is present at either end.

On examining this region microscopically, a very thin, delicate, almost transparent intima is found lining it throughout. The epithelium just outside possess cuboidal cells, except in some of the fold-like projections where they are more or less flattened and irregular in form.

The epithelium of the distal ileum is traversed by six longitudinal rows of papillate processes which extend into its lumen (Fig. 12, Plate II). The number of these projections per row vary according to their location on the ileal wall. Along the concave wall of this structure the protrusions vary in number from eight to ten, while on the opposite convex side, the variation is between twelve and sixteen. The total number of papilliform processes for the entire organ may vary from sixty to almost a hundred. These processes also vary considerably in size, those found in the middle portion of the distal ileum being much larger than those at each of its ends.

The intima enveloping these protrusions is covered with small spines which seem to aid in holding the cone-like mass of non-cellular

material which fits down over each one. (Fig. 13, Plate II). This matrix assumes a deep blue color when stained with Delafield's Haemotoxylin. In it appear clear ovate objects which may be protozoa. A single median longitudinal section, seven micra in thickness, may contain nearly a hundred of these objects. It is possible that bacteria may produce this anomalous medium and that there might be a symbiotic relationship existing between protozoa and bacteria in this connection.

The circular layer of muscles surrounding the hypodermal epithelium of the distal ileum is quite well developed. Groups of them may be seen at the bases of small folds in the hypodermis in longitudinal sections. They are however found elsewhere as scattered strands beneath the epithelium.

The longitudinal muscles on the other hand are not as well developed and only an occasional strand is found.

Traces of "peritoneal membrane" are also present.

The *colon* is defined anteriorly by the distal ileum and posteriorly by the rectum, with which it gradually merges. The colon is a long slender tube with a diameter of about one-third that of the distal ileum.

The intima of this division of the tract is somewhat thicker than that in the ileum.

The epithelial cells of the colon are cuboidal in shape, possessing very large nuclei. A basement membrane is evident.

That side of the colon comparable to the concave side of the distal ileum is a short row of a dozen or so large spines which project caudad into the lumen of the colon. Also there are six large longitudinal folds in the epithelium of this region which are quite evident in cross-sections. (Fig. 14, Plate II).

The circular muscle layer of the colon is well developed and cross-sections of this part of the canal show a continuous band of them surrounding the epithelium.

The longitudinal muscles, however, are very poorly developed, only from two to four isolated groups being evident in a cross-section.

The *rectum* is very similar to the colon in make-up. The transition from one to the other takes place gradually. Externally the rectum is a dilation of the posterior end of the alimentary canal.

The intima and epithelium, as in the colon, are thrown into six large longitudinal folds and are known as rectal pads. The intima, however, is very thick, and in this respect, differs decidedly from the colon. The epithelial cells are of the cuboidal type and rest on a basement membrane that shows up more definitely here than in any other part of the canal.

The circular muscles are well-developed in this section of the alimentary tract, five of six layers of them being present.

The longitudinal muscles as in the rectum are few and inconspicuous. A small number of isolated groups comparable to those in the colon are present in cross-sections of this region. (Fig. 15, Plate II).

The "peritoneal membrane" of connective tissue appears much the same as it does in other divisions of the tract.

Conclusion.

The alimentary canal of *Phyllophaga gracilis* is of medium length, corresponding to its phytophagus habits. In correlation with other insects this canal is made up of three primary regions. The fore-intestine (Stomodaeum) and the hind-intestine (Proctodaeum) both ectodermal in origin and the mid-intestine (Mesenteron) which has an endodermal origin.

These three regions, however, are more or less specialized and differentiated, exhibiting the following modifications:

Fore-intestine:—Pharynx, oesophagus, crop and oesophageal valve.

Mid-intestine:—Entirely stomach.

Hind-intestine:—Pyloric valve, Malpighian tubules, proximal ileum, distal ileum, colon and rectum.

This study of the alimentary canal needs considerably more attention before a thorough understanding can be secured. The physiology of the digestive system should be worked out, in order to learn the exact relationships of the nidi and replacement cells, in this connection. The nidi afford considerable interest since they have in many cases broken not only through the basement membrane but also through the surrounding muscle layers. Such a study would be the best possible way to determine the type of secretion and absorption.

The condition existing in the distal ileum likewise requires an even more detailed study with fresh material, before a possible solution of its nature can be given. In this part of the ileum the papillate processes surrounded by an anomalous medium, filled with clear ovate objects resembling protozoa of the Microsporidian type present the most interesting situation in the whole alimentary canal of this beetle. It is hoped that further study will give a clue to the identity of these structures.

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EXPLANATION OF PLATES.

Plate I.

Fig. 1. A dorsal view of the Alimentary Canal. Col.—colon; crop; D. Il.—Distal Ileum; Mal. T.—Malpighian Tubules; M. Int.—Mid-intestine; Oes.—Oesophagus; Oes. V.—Oesophageal valve; Ph.—Pharynx; P. Il.—Proximal Ileum; Py. V.—Pyloric valve; Rec.—Rectum.

Fig. 2. Cross-section through pharynx. C. Mus.—Circular Muscle; Epi.—Epithelium; Int.—Intima; L. Mus.—Longitudinal muscle; Sp.—Spine.

Fig. 3. Cross-section of Proximal ileum. Oil emersion drawing. C. Mus.—Circular muscle; Epi.—Epithelium; Int.—Intima; L. Mus.—Longitudinal Muscle.

Fig. 4. Longitudinal section through the oesophageal valve. C. Mus.—Circular Muscle; Epi.—Epithelium; Int.—Intima; L. Mus.—Longitudinal Muscle; Oes. V.—Oesophageal valve; P. mem.—"Peritoneal membrane."

Fig. 5. Cross-section through oesophagus. C. mus.—Circular muscle; Epi.—Epithelium; Int.—Intima; L. mus.—Longitudinal muscle.

Fig. 6. Cross-section of mid-intestine. C. mus.—Circular muscle; Epi.—Epithelium; F. T.—Fat tissue; L. mus.—Longitudinal muscle; Nidus; R. cell—Replacement cell.

Fig. 7. Longitudinal section through mid-intestine. C. mus.—Circular muscle; Epi.—Epithelium; F. T.—Fat tissue; L. mus.—Longitudinal muscle; Nidus.

Plate II.

Fig. 8. A longitudinal composite section through region of pyloric valve. C. mus.—Circular muscle; Epi.—Epithelium; Int.—Intima; Malp. Tub.—Malpighian Tubule; L. mus.—Longitudinal muscle; Py. valve—Pyloric valve.

Fig. 9. Cross-section through Malpighian tubule near extremity. Oil emersion drawing.

Fig. 10. A typical cross-section through a Malpighian tubule. Oil emersion drawing.

Fig. 11. Cross-section of Malpighian tubule near its origin. Oil emersion drawing. Epi.—Epithelium; P. mem.—"Peritoneal membrane" or connective tissue; St. B.—Striated border.

Fig. 12. Cross-section through distal ileum. Pap. Proc.—Papillate Process.

Fig. 13. Longitudinal section through distal ileum showing a papillate process. Oil emersion drawing. A. Med.—Anomalous medium; C. mus.—Circular muscle; Epi.—Epithelium; Int.—Intima; L. mus.—Longitudinal muscle; M. S.—Probably protozoa of the Microsporidian type; Sp.—Spine.

Fig. 14. Cross-section through the colon. C. mus.—Circular muscle; Epi.—Epithelium; Int.—Intima; L. mus.—Longitudinal muscle.

Fig. 15. Cross-section through the rectum. C. mus.—Circular muscle; Epi.—Epithelium; Int.—Intima; L. mus.—Longitudinal muscle.

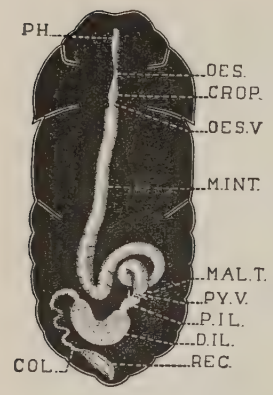


FIG.1.

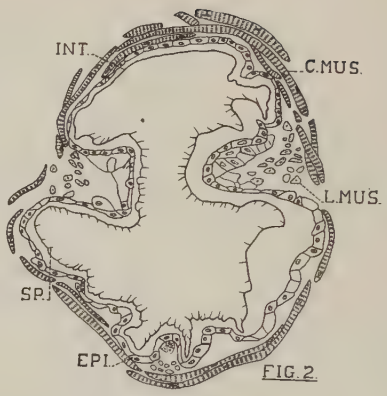
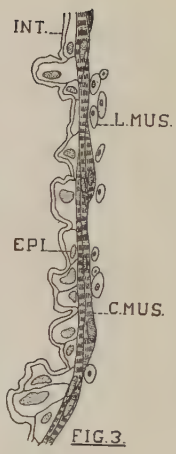


FIG. 2.



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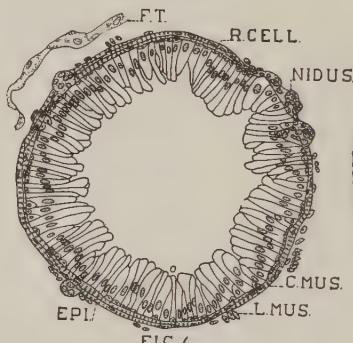

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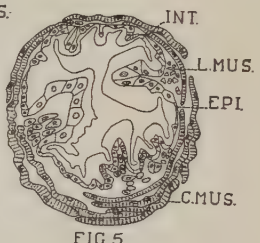
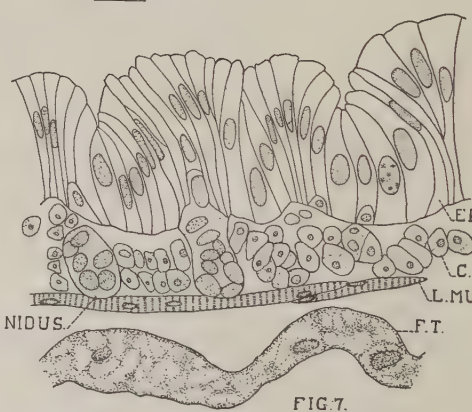


FIG.5.

FIG.4.



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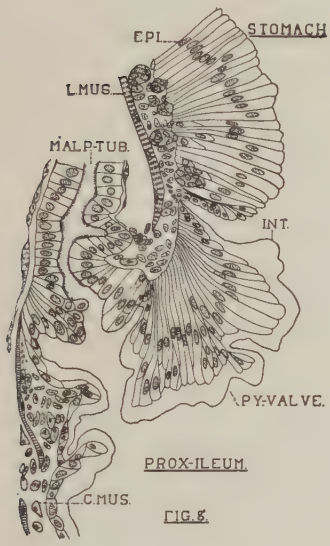

FIG. 8.

FIG. 9.

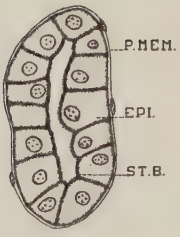

FIG. 11.

FIG. 10.

FIG. 12.

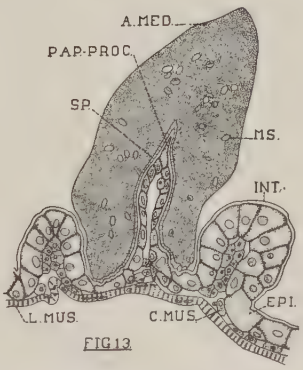

FIG. 13.

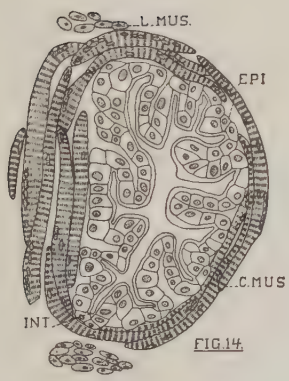

FIG. 14.

FIG. 15.

THE ALIMENTARY CANAL OF PHILAENUS LEUCOPHTHALMUS L.*

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Introduction.

A study of the alimentary canal of *Philaenus leucophthalmus* L. was undertaken to determine the gross and histological structure of the tract and the source of the "spittle" with which the nymphs of this well known species of cercopid cover themselves.

This work was begun as a study in internal morphology, under the direction of Dr. C. H. Kennedy at the Ohio State University. Owing to the complexity of the alimentary canal, the work was not completed in the allotted time but has been continued as time permitted. The assistance and suggestions of Dr. Kennedy have been a great aid in the progress of the study.

Methods.

Various methods of gross dissection were used at first without success. Serial sections were then prepared and drawings were made of each in an effort to reconstruct the complex diverticular region of the canal. Owing to the numerous loops and convolutions of the structures involved, this method also was unsuccessful. In fact, the completion of the study was almost despaired of until the following method for dissecting was discovered:

The specimen to be dissected was placed in a vial and given an anesthetic of ether or chloroform. As soon as the insect became quiet, it was removed from the vial to a dissecting dish which had a layer of blackened paraffin in the bottom. The specimen was then placed dorsal side up in normal position and its legs imbedded in the paraffin by melting the paraffin around them with a hot needle. When the paraffin cooled, the specimen was held securely by its legs. The insect was then covered with lukewarm normal saline solution. The usual method of gross dissection was followed with as much speed

* Contribution No. 100 from the Department of Zoology and Entomology, Ohio State University.

and caution as possible. The advantage of dissecting a live specimen lies in the transparency of live tissue. The convolutions of the stomach in the folds of the diverticula can be seen through the transparent covering of connective tissue on a living specimen. This can not be done on a dead specimen since dead tissue is opaque.

For the histological study the best sections were secured by the following method:

Nymphs and adults, collected just after molting, were killed by placing them in hot water at 70° C. for 3 minutes, fixed in Kahle's solution for 24 hours, and stored in 70 per cent alcohol. For study, after the usual preparation they were imbedded in paraffin, cut into sections 10 microns thick, mounted, and stained in hematoxylin and eosin.

Gross Anatomy of the Alimentary Canal.

The Cercopidæ secure their food by piercing the host plant with the modified mandibles and maxillæ, which rest in the grooved labium, and then pumping the liquid or sap up the tube from the rostrum by means of the pharynx.

The ducts of the salivary glands empty into the mouth cavity just anterior to the pharynx. There are two pairs of salivary glands which lie parallel to the oesophagus, (Fig. 1). One pair is above and laterad and the other ventrad and laterad of the oesophagus. The upper two are almost cylindrical whereas the lower two are club-shaped and taper posteriorly. Their length is approximately the same as that of the oesophagus. Each gland has a duct that leads anteriorly into the head where the duct of the lower gland fuses with the corresponding duct from the upper gland. The two ducts coil in the head region and then empty into the mouth cavity.

The pharynx is an enlargement of the fore intestine. It is slightly diamond shaped, is situated in the head posterior to the brain, and operates as a pump by means of numerous pharyngeal muscles. Food passes from the pharynx into the oesophagus.

The oesophagus is a long tube connecting the pharynx and oesophageal valve. It decreases in size posteriorly to the anterior region of the mesothorax, then enlarges slightly. This enlargement may indicate the remains of a crop. The oesophagus decreases in size in the metathoracic region, where the oesophageal valve is located. See Plate II, fig. 6.

The oesophageal valve is well developed structurally in this species and marks the division between the fore intestine and the mid-intestine. Before the first and second divisions of the stomach are "teased" apart the location of the oesophageal valve is often not apparent.

The mid-intestine begins at the oesophageal valve and ends at the point where the Malpighian tubes enter the canal. The anterior end of the mid-intestine is composed of two large pouch-like structures.

From a dorsal view, the first pouch or anterior diverticulum is located to the right and is slightly kidney shaped. Adjoining this pouch, slightly posteriorly and to the left, is a second pouch or posterior diverticulum of approximately the same size but less muscular.

The heavy walled anterior diverticulum retains its approximate position in a dead specimen, but the posterior diverticulum usually collapses and folds posteriorly, (Plate II, fig. 6). When the muscles and tissue connecting the two pouches are severed it is seen that the anterior and posterior diverticula are connected as shown in Plate I, Figure 2. The posterior diverticulum tapers posteriorly from the first to the second abdominal segments, then proceeds as a small, thin walled, light pink gut that continues ventrally and posteriorly to the 5th or 6th abdominal segment. The gut is constricted at this point and then immediately enlarges to twice its former size, (Figs. 1 and 13). Besides being of much larger size the gut is now yellow and opaque, and is full of irregular shaped objects. This yellow portion of the gut is easily seen through the semitransparent body wall of the nymph at the sixth or seventh segment. The gut continues to loop cross-wise of the body to the seventh abdominal segment; then turns and proceeds anteriorly, the yellow colored granules being present to about the third abdominal segment, where they gradually disappear. This condition exists in both nymphs and adults. As the granules decrease in number the gut assumes the same size and color as that portion which is anterior to the constriction. After many loops this portion of the stomach appears to enter the anterior diverticulum, at various points as shown in Plate I, Figures 2, 3, 4 and 5. The portion just described, with the constriction, has been described by Gadd (2)* as two blind caeca and the constriction given as the point where the two caeca had fused. This investigator was confused because the gut just described apparently entered the first pouch and because a second gut from this pouch proceeded to the anus. What became of the gut that entered the pouch and where the one leaving it came from was a mystery in this study until the method of gross dissection, previously described, was discovered.

The posterior portion of the mid-gut may also disappear under a fold of the wall of the posterior diverticulum as shown in Plate II, Figure 6, but is usually enfolded only by the anterior diverticulum as shown in the simplified diagrammatic drawings of Plate I, Figures 3, 4 and 5. The posterior mid-gut usually ascends in a fold of the diverticulum with few loops, to a point laterad of the oesophageal valve where the two pairs of Malpighian tubes are attached. There is an enlargement of the gut at this point which may be the location of a pyloric valve, though no valve was recognized in cross or longitudinal sections from this region. From this point the descending gut is the hind intestine.

The hind intestine extends from the point of attachment of the Malpighian tubules to the anus. The anterior portion makes several loops as it zigzags posteriorly in the fold of the wall of the anterior diverticulum before it appears at the posterior tip, (Plate I, Fig. 2).

*Number in parenthesis refers to Literature cited, page 127.

This intestine loops crosswise of the body and lies near the dorsal body wall, (Plate I, Fig. 1). The hind intestine is of uniform size to about the eighth abdominal segment, where it enlarges to form the rectum.

The Malpighian tubes are four in number and join the hind intestine as shown in Plate I, Figure 2.

The ascending anterior portions of the Malpighian tubes become small, thin-walled, and symmetrical just before they are enfolded by the anterior diverticulum and remain so to the point of attachment. Their posterior portions are relatively large, irregular in shape and have the appearance of a string of beads. This characteristic bead shape of the Malpighian tubes is due to the size and shape of the cells, (Plate II, Figure 16).

The Malpighian tubules lie next to the dorsal body wall and make crosswise loops similar to those of the descending hind intestine. They extend posteriorly to the seventh or eighth abdominal segment, and terminate with blind ends.

The rectum is a heavy walled, straight tube, that ends at the external anal opening, (Plate I, Fig. 1).

Histology of the Alimentary Canal.

The fore intestine from a histological point of view is not unusual. It is lined with a thin layer of chitin or intima which is extremely thin in the region of the oesophageal valve. The hypodermal cells of the oesophagus are well developed. In the anterior portion the cells have relatively large nuclei, are crowded, and assume a columnar shape. The cells of the middle to posterior portion of the oesophagus are cuboid in shape with rather elongated nuclei. In the oesophageal valve region the cells are much crowded, very long, with the nuclei as wide as the cell. (See Plate II, Fig. 6.)

The large salivary glands that are located parallel to the oesophagus have a peculiar cell structure. The upper pair have large cells with numerous irregular shaped lumens that are perhaps portions of connecting ducts, (Fig. 11). The lower pair of salivary glands is much larger than the upper pair and the cell arrangement gives them the appearance of rosettes. In cross section (Fig. 12) there is seen a common central duct with cells arranged around the duct. A chitinous lined duct results from the union of the ducts from the upper and lower glands, and this coils in the head region before entering the mouth.

The oesophageal valve is not formed by a folding of the fore intestine but by special elongated cells. This is unusual since an oesophageal value is usually formed by the fore intestine extending into the mid-intestine, then folding back upon itself, outward, to the anterior edge of the mid intestine. An oesophageal valve formed by elongated cells has the shape of one formed by a fold of the fore intestine and no doubt is just as efficient.

The mid-intestine or stomach is that part of the alimentary canal posterior to the oesophageal valve and anterior to the entrance of the Malpighian tubules. There is no cuticular covering of the digestive epithelium in the mid-intestine. The cells of the mid-intestine are

rather small and flattened in the region of the oesophageal valve, but posteriorly they become more columnar and irregular in size and shape. The first section of the stomach is unusual in that the portion lined with digestive epithelium is very small in relation to the size of the pouch. The capacity of this section of the stomach is reduced by crowding, caused by the folding of the stomach wall around portions of the hind-intestine and mid-intestine and Malpighian tubes. Plate II, Figure 6, shows a longitudinal section through the oesophagus, and anterior and posterior diverticula. This section shows that a large portion of the anterior diverticulum is occupied by the many loops of the Malpighian tubes and the mid-intestine and hind-intestine between folds of the diverticular wall. The posterior diverticulum shown in Figure 6 has also folded over a portion of the stomach and Malpighian tubes. This enclosing, by folding of the posterior diverticulum, occurs when these parts cross the diverticulum as shown in Plate I, Figure 1. The intestine and Malpighian tubes are not usually folded under by this section. It should be noted that the loops of the intestine and Malpighian tubes do not enter the stomach but are only under folds of the diverticular walls and are sealed over with connective tissue. This enfolding of the alimentary canal by the diverticulum is present in first-instar nymphs and evidently first occurs in the embryonic development.

The cells of the anterior diverticulum are large, irregular in size, and columnar in shape. The same type of cell continues throughout the stomach, but with variations in size. The largest epithelial cells occur in the posterior diverticulum and the smallest cells occur posterior to the stomach constriction. The constriction of the stomach shown in Plate I, Figure 1, and Plate II, Figure 13, located at the posterior end of the fifth abdominal segment is not a valve. Longitudinal and cross sections were made through the constriction in the stomach, and these failed to reveal any trace of a valve. (Fig. 13).

Posterior to the constriction the gut is always full of large yellow bodies that have the consistency of cheese. These bodies have large nuclei and in the cytoplasm are transparent particles. Kershaw (5) has described a similar body found in the alimentary canal of *Tomaspis saccharina* Dist., a cercopid. He had the contents of two nymphal posterior guts analyzed and reports the granules to be amorphous insoluble calcium phosphate and to constitute 80 per cent of the content of the gut.

The function of these yellow bodies in the alimentary canal is not known. Their color is undoubtedly due to bacteria, since four pure strains which produced yellow colonies on beef agar have been isolated on numerous occasions from smears taken from one of these macerated bodies. A further study is planned of the fauna of the alimentary canal of this spittle bug and this should give some interesting results.

The ascending portion of the gut in the folds of the anterior diverticulum is stomach to the point of entrance of the Malpighian tubes, (Plate I, fig 2). The large digestive epithelial cells disappear in the alimentary canal at this point, and the intestine posterior to this point is lined with chitin, which is definite proof that the division of stomach

and hind intestine has been reached. A slight enlargement at this point may indicate a pyloric valve, although no trace was found of one in sections from this region.

The cells of the rectum are relatively small and uniform throughout this portion of the canal, and there is very little variation in the thickness of the chitinous lining. (See Figures 13 and 14.)

Source of Spittle or Froth.

The source of the small white frothy masses noticed on many plants in the spring of the year has been explained in many and various ways. It was first written by Isidorous, cited by Gruner (3), in the sixth century that these white spittle masses were spit of the cuckoo bird and that small insects were spontaneously generated from it. It was also thought that certain plants secreted the spittle mass. According to Gruner (3), Bock in 1546 made a list of the plants that produced spittle. There are even sections of this country today where the people believe these spittle masses are the spit of snakes or cuckoos. These explanations of the source of the spittle, along with many other such theories, we know to be incorrect.

There are also several other more modern theories which have been advanced in explanation of the production of the spittle. It has been thought that the spittle is the production of salivary glands, or of special glands located in the abdomen, such as the Glands of Batelli, and the Malpighian tubules.

This study to determine the source of the spittle has consisted of field observations, laboratory experiments, and study of the histological structure.

The field observations on habits of the spittle-bug nymphs showed two things of interest; first, that all cercopid nymphs observed always elevate the posterior end of the abdomen, and, second, that they occasionally extend and retract the posterior segments in a telescoping fashion. This position of the abdomen is maintained at all times but the movement described takes place at short intervals when the nymph is covered with the clear fluid before bubbles are formed. These two habits are important in the formation of the spittle. A spittle-bug nymph removed from its covering of spittle to dry blotting paper will lose its external covering of fluid. When this nymph is replaced on a plant it soon locates a favorable spot for feeding, and inserts its beak into the plant tissue. Observation records show that the nymph moves its middle and posterior pairs of legs at intervals while feeding. This movement of the legs has been described by Guilbeau (4) as a means used by the nymph to mix the spittle as secreted. This habit of moving the legs when feeding is evidently not exclusively a function necessary to the production of spittle, since it has been observed as common to many Hemiptera and is not restricted to cercopids. The nymph increases in size as it feeds, and after feeding from 1 to 2 minutes it excretes a clear fluid from the anus. In from 5 to 12 minutes the nymph is completely covered with the fluid. The position of the tip of the abdomen when the fluid is excreted, causes the fluid to flood the dorsal surface of the abdomen and run off the sides of the body. When the

nymph is covered with clear fluid the tip of the abdomen is extended outside the fluid. While outside the fluid, the posterior lateral folds are opened to allow entry of air, then closed as the abdomen is retracted into the fluid. The body of the nymph is then contracted and a bubble of air is released into the fluid. This process is performed repeatedly until the clear fluid becomes a white frothy mass or spittle. In the method of forming the spittle I agree with Morse (7) but do not agree with him that the anal appendages serve as gills when the nymph is covered with spittle.

A study of the ventral external structure of the spittle-bug nymphs shows how air is taken and released. The sternal body wall is almost a flat surface, but the terga and pleura are greatly extended and when folded under the abdomen, meet and form a closed tube, or air space, for the entire length of the abdomen. It is evident that this tube is filled with air when the tip of the abdomen is thrust outside the fluid, and that when the abdomen is retracted under the fluid air is released and forms the bubbles. This air reservoir also has the function of transmitting air to the spiracles for use by the insect, since the spiracles are located in this region. The location of the spiracles and existence of the air reservoir explain how the nymphs breathe even though submerged in the spittle.

We have seen from observations that the clear fluid of which the spittle is formed is excreted at the anus.

The detailed histological study disproved several of the theories as to the source of the spittle. It is evident that the salivary glands do not directly secrete the fluid for the spittle, since the secretion from these glands is carried by ducts to the mouth. No special spittle glands were found in any part of the body of the species studied. The glands of Batelli (1) are described as being located on the seventh and eighth abdominal segments and to secrete a semi-solid material through the chitin of the seventh and eighth somites which is mixed with the excretion from the anus by use of the second and third pairs of legs to form the spittle. These glands or openings were not found in this study.

The theory that the anterior smooth portion of the Malpighian tubes secretes the fluid with which the spittle is formed can not be disproved at this time; however, this theory does not appear logical. The anterior smooth portion of the Malpighian tubes has very thin walls composed of small cells. This structure is not compatible with the fact that spittle bugs secrete a relatively large quantity of clear fluid in a short time. Also it has been proved experimentally that a spittle-bug nymph will die without forming spittle unless it can find a plant on which to feed. If the spittle were a secretion, the glands should possess enough stored fluid to produce at least a small quantity of spittle without feeding. This is not the case since many nymphs have been held under observation, and they have always fed for at least 1 minute before excreting any fluid. A nymph that is removed from a spittle mass and then replaced on a plant will enter the first spittle mass encountered, evidently seeking protection before food. A nymph placed on a semidry, cut plant is able to insert its proboscis, but owing to the dryness of the plant is unable to secure any sap. Under these

conditions a nymph does not excrete any fluid for spittle which would act as a protective covering. This indicates that the nymphs require food before any liquid is excreted for spittle. The fact that no special glands with anal openings were found in this study, and that other investigators have observed that the clear liquid is excreted at the anus, indicates that the clear fluid from which the spittle is formed is the normal excretion from the alimentary canal. The excretion would include secretions and excretions from the different cells and glands throughout the alimentary canal. It is evident that the quantity of excretion is determined by the rate of feeding or that the spittle-bug nymph is able to control the rate of flow of sap through the alimentary canal.

Licent (6) found by analysis that spittle consisted of 99.44 per cent water, 0.14 per cent organic matter, and 0.38 per cent inorganic material and that plant sap consisted of 94.57 per cent water, 3.83 per cent organic material, and 1.61 per cent inorganic material. The results of these analyses are additional proof that spittle is formed from excretion filled with air bubbles.

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EXPLANATION OF PLATES.

Plate I.

Fig. 1. Diagrammatic dorsal view showing alimentary canal of nymph of *Philaenus leucophthalmus*.

Fig. 2. Simplified diagrammatic drawing showing ventral view of anterior and posterior diverticulum, showing route of gut and Malpighian tubes, enfolded by anterior diverticulum.

Figs. 3, 4 and 5. Diagrammatic drawing showing entry of stomach in folds of diverticulum.

Plate II.

Fig. 6. Longitudinal section through oesophagus, oesophageal valve, anterior and posterior diverticula, showing by dotted line position of diverticula when expanded.

Note—Posterior diverticulum has enfolded a portion of stomach and Malpighian tubules.

Fig. 7. Cross-section through anterior and posterior diverticula before they join.

Fig. 8. Cross-section through anterior and posterior diverticula showing constriction where they join. This section is posterior to Figure 7.

Fig. 9. Cross-section through oesophagus.

Fig. 10. Cross-section through oesophagus posterior to Figure 9.

Fig. 11. Cross-section through upper salivary gland.

Fig. 12. Cross-section through lower salivary gland.

Fig. 13. Longitudinal section through stomach showing constriction and presence of yellow bodies posterior to constriction.

Fig. 14. Cross-section through rectum.

Fig. 15. Cross-section through rectum posterior to Figure 14.

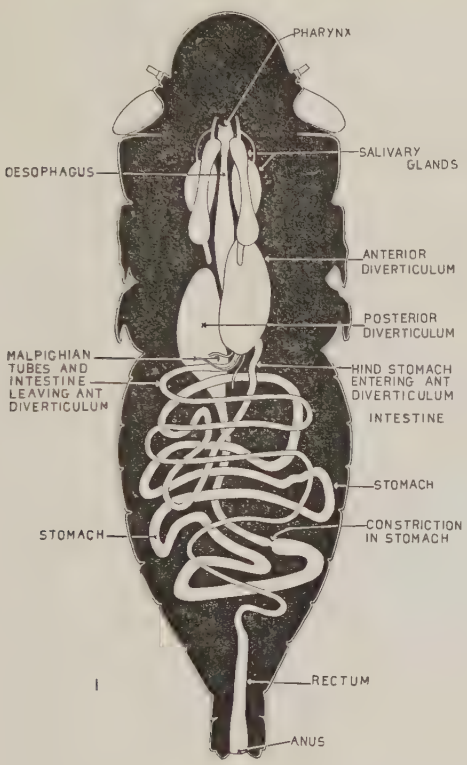
Fig. 16. Cross and longitudinal section through beaded part of Malpighian tubule.

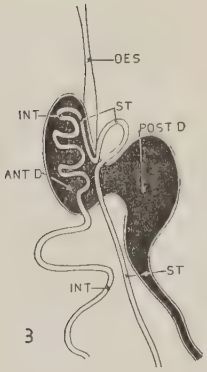
EXPLANATION OF ABBREVIATIONS.

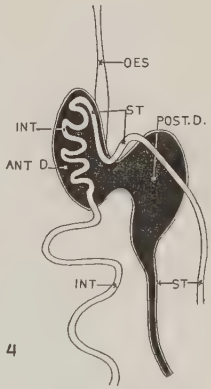
Ant. D.....Anterior diverticulum.
D. E.....Diverticulum expanded.
Fat.....Fat tissue.
Int.....Intestine.
Mal. T.....Malpighian tubes.
M. T. A.....Malpighian tubes attachment.
Oes.....Oesophagus.
Oes. V.....Oesophageal valve.
Post D.....Posterior diverticulum.
Post. D. E..Posterior diverticulum expanded.
St.....Stomach.

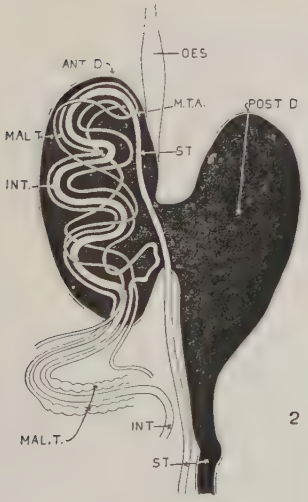
Alimentary Canal of Philaenus.
Rodney Cecil.

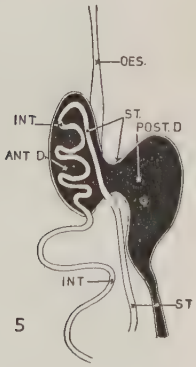
PLATE I

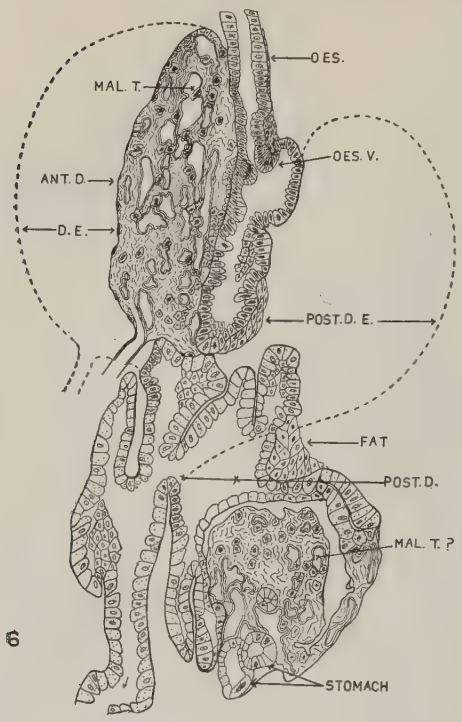












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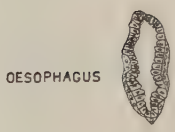

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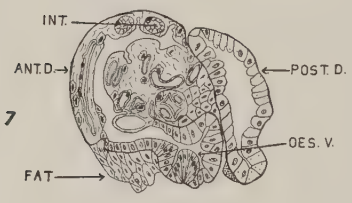

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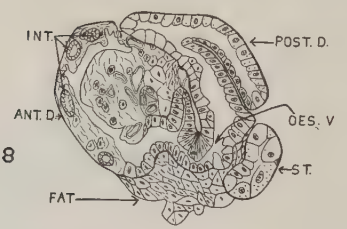

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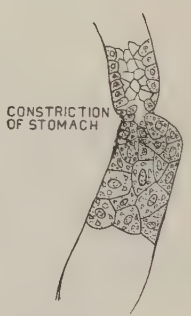

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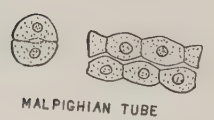

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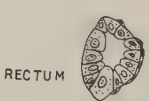

14

PRELIMINARY REPORT OF THE ALGAE OF KENTUCKY.

B. B. McINTEER,
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After spending a summer in the study of algae at the Franz Theodore Stone Laboratory of The Ohio State University, the writer began an algal survey of the State of Kentucky, under the direction of Dr. L. H. Tiffany, of that institution. This preliminary report is the result of an analysis of collections made during the period August 1, 1928, to June 11, 1929.

Very few, if any, forms of algae have ever been reported from Kentucky. Perhaps algae are as numerous, grow as abundantly, and are as easily collected in Kentucky as in any inland state. Heretofore the men of Kentucky who were interested in the study of algae were not sufficiently interested to make a survey or report of any kind concerning these plants. It is hoped that this preliminary report will be followed by others on the algal flora of the state.

Most of the collections were made in two distinct regions of the state. The first is the Blue Grass Region, where the geological formation is Ordovician and where different bodies of water range from neutral to slightly alkaline (pH 8.4 perhaps being about the highest). The second region is Hart County and some of the adjoining counties. This region has a different soil formation, being the Mississippian. Here the water is slightly acid. In this region the number of collections was very small, but a great many forms of algae were found, especially Desmids. It is thought that when collections can be made at other times of the year and in other parts of the state that many other forms can be added to the list because of the periodicity of the various forms of algae, the types of soil formation and the differences in the reaction of the water.

Several persons have assisted me in this work by sending or bringing collections from their respective communities. The samples were preserved in Transeau's solution, made with 6 parts water, 3 parts alcohol, and 1 part formalin.

Of the 120 counties in the state, only 21 are represented in this report, and only 2 of these are represented by more than

100 forms of algae, and only 6 by more than 10 forms. The highest ranking counties with the number of forms in each are Fayette, 239; Hart, 130; Jessamine, 47; Clark, 29; Larue, 21, and Barren, 17. Of the 373 forms in this report, 263 have been found in only one county, while each of the other 110 have been found in two or more counties.

The genera and species of this report are listed alphabetically under each family represented.

MYXOPHYCEÆ CHROOCOCCEÆ.

CHROOCOCCALES.

Chroococcaceæ.

Aphanocapsa biformis A. Braun. Fayette Co. **A. grevillei** (Hassall) Rabenhorst. Fayette Co.

Aphanothece stagnina (Sprengel) A. Braun. Fayette Co.

Chroococcus decorticans A. Braun. Fayette Co. **C. minutus** (Kützing) Nägeli. Fayette Co. **C. turgidus** (Kützing) Nägeli. Fayette Co.

Coelosphaerium dubium Grunow. Fayette Co. **C. kuetzingianum** Nägeli. Fayette Co. **C. naegelianum** Unger. Fayette Co., Hart Co., Jessamine Co.

Gloeocapsa gigas W. & G. S. West. Nelson Co.

Gomphosphaeria aponina Kützing. Hart Co. **G. lacustris** Chodat. Hart Co.

Merismopedia convoluta Brebisson. Carroll Co., Fayette Co., Garrard Co., Hart Co., Hickman Co. **M. glauca** (Ehrenberg) Nägeli. Fayette Co. var. **fontinale** Hansgirg. Hart Co. **M. punctata** Meyen. Barren Co. **M. tenuissima** Lemmermann. Fayette Co.

Microcystis aeruginosa Kützing. Fayette Co. var. **major** (Wittrock) G. M. Smith. Fayette Co., Jessamine Co. **M. flos-aquae** (Wittrock) Kirchner. Fayette Co. **M. marginata** (Meneghini) Kützing. Fayette Co.

HORMOGONEÆ.

HORMOGONEALES.

Oscillatoriaceæ.

Lyngbya aestuarii (Mertens) Liebmann. Barren Co., Hart Co., Jefferson Co. **L. birgei** G. M. Smith. Fayette Co. **L. major** Meneghini. Fayette Co., Hart Co. **L. martensiana** Meneghini. Fayette Co. **L. spirulinoides** Gomont. Fayette Co.

Microcoleus vaginatus (Vaucher) Gomont. Fayette Co.

Oscillatoria amphibia Agardh. Barren Co., Fayette Co. **O. annæ** van Goor. Hart Co. **O. chlorina** Kützing. Fayette Co. **O. formosa** Bory. Fayette Co., Jessamine Co. **O. jenensis** G. Schmid. Hart Co. **O. limosa** Kützing. Fayette Co., Hart Co. **O.**

minnesotensis Tilden. Fayette Co. **O. ornata** Kützing. Fayette Co. **O. princeps** Vaucher. Barren Co., Clark Co., Fayette Co., Hart Co., Hickman Co., Wolfe Co. **O. sancta** Kützing. Fayette Co., Wolfe Co. **O. splendida** Greville. Fayette Co., Rowan Co. **O. subtilissima** Kützing. Fayette Co. **O. tenuis** C. A. Agardh. Campbell Co., Fayette Co.

Phormidium ambiguum Gomont. Fayette Co. **P. autumnale** (Agardh.) Gomont. Fayette Co. **P. laminosum** (Agardh) Gomont. Fayette Co. **P. retzii** (Agardh) Gomont. Fayette Co. **P. uncinatum** (Agardh) Gomont. Fayette Co., Wayne Co.

Spirulina nordstedtii Gomont. Wayne Co.

Nostocaceæ.

Anabaena affinis Lemmermann. Fayette Co., Hart Co. **A. hallensis** (Janczewski) Bornet & Flahault. Fayette Co. **A. macrospora** var. **robusta** Lemmermann. Fayette Co. **A. planctonica** Brunnthaler. Fayette Co. **A. spiroides** Klebahn. Fayette Co., Hart Co. var. **contracta** Klebahn. Fayette Co. **A. torulosa** (Carm.) Lagerheim. Fayette Co.

Aphanizomenon flos-aquae (L.) Ralfs. Fayette Co.

Cylindrospermum alatosporum Fritsch. Fayette Co. **C. catenatum** Ralfs. Fayette Co. **C. lichenforme** (Bory) Kützing. Fayette Co. **C. muscicola** Kützing. Fayette Co.

Nodularia harveyana (Thwaites) Thuret. Clark Co., Fayette Co., Jessamine Co.

Nostoc comminutum Kützing. Fayette Co. **N. commune** Vaucher. Fayette Co. **N. microscopicum** Carmichael. Fayette Co. **N. muscorum** Kützing. Fayette Co. **N. piscinale** Kützing. Fayette Co.., Jessamine Co.

Scytonemataceæ.

Scytonema intertextum (Kützing) Rabenhorst. Fayette Co.

Rivulariaceæ.

Calothrix fusca (Kützing) Bornet & Flahault. Fayette Co.

Gloeotrichia echinulata (J. E. Smith) Richter. Hart Co.

CHRYSOPHYCEÆ.

OCHROMONADALES.

Ochromonadaceæ.

Dinobryon setularia Ehrenberg. Rowan Co.

RHODOPHYCEÆ FLORIDEÆ.

NEMALIONALES.

Lemaneaceæ.

Lemanea torulosa (Roth) Agardh. Fayette Co.

HETEROKONTEÆ.

HETEROTRICHALES.

Tribonemaceæ.

Tribonema bombycina (Agardh) Derbes & Solier. Fayette Co., Larue Co., Rowan Co. forma **tenue** Hazen. Fayette Co. **T. raciborskii** Heering. Fayette Co. **T. utriculosa** Kutzing. Fayette Co.

HETEROSIPHONALES.

Botrydiaceæ.

Botrydium granulatum (L.) Greville. Fayette Co.

CHLOROPHYCEÆ ISOKONTÆ.

VOLVOCALES.

Chlamydomonadaceæ.

Chlamydomonas snowii Printz. Fayette Co.

Volvocaceæ.

Eudorina elegans Ehrenberg. Clark Co., Fayette Co., Jessamine Co., Scott Co.
Gonium pectorale Muller. Fayette Co.
Pandorina morum Bory. Clark Co., Fayette Co., Hart Co., Jessamine Co.
Pleodorina californica Shaw. Clark Co., Fayette Co., Hart Co., Jessamine Co. **P. illinoisensis** Kofoid. Fayette Co.
Volvox aureus Ehrenberg. Hart Co. **V. mononæ** G. M. Smith. Clark Co.

CHLOROCOCCALES.

Palmellaceæ.

Gloeocystis gigas (Kützing) Lagerheim. Fayette Co.
Planctosphaeria gelatinosa G. M. Smith. Fayette Co.
Sphaerocystis schroeteri Chodat. Fayette Co.
Tetraspora gelatinosa (Vaucher) Desvaux. Clark Co., Fayette Co., Scott Co. **T. lacustris** Lemmermann. Fayette Co. **T. lubrica** (Roth) Agardh. Fayette Co.

Hydrodictyaceæ.

Hydrodictyon reticulatum (L.) Lagerheim. Clark Co., Fayette Co., Jessamine Co., Washington Co.
Pediastrum biradiatum Meyen. Fayette Co. **P. boryanum** (Turpin) Meneghini. Fayette Co., Jessamine Co. **P. duplex** Meyen. Fayette Co., Hart Co. var. **clathratum** (A. Braun) Lagerheim. Fayette Co. var. **cohaerens** Bohlin. Fayette Co. var. **gracillimum** W. & G. S. West. Fayette Co. var. **reticulatum** Lagerheim.

Fayette Co. **P. kawraiskyi** Schmidle. Fayette Co. **P. ovatum** (Ehrenberg) A. Braun. Fayette Co. **P. simplex** var. **duodenarium** (Bailey) Rabenhorst. Fayette Co., Hart Co., Hickman Co., Jessamine Co., Larue Co. **P. sturmii** Reinsch. Fayette Co. **P. tetras** (Ehrenberg) Ralfs. Clark Co., Fayette Co., Hart Co. var. **tetraodon** (Corda) Hansgirg. Barren Co., Clark Co., Fayette Co., Hart Co.

Chlorococcaceæ.

Characium limneticum Lemmermann. Fayette Co., Garrard Co. **C. stipitatum** (Bachmann) Wille. Fayette Co.

Chlorococcum infusionum (Schrank) Meneghini. Fayette Co.

Dictyosphaeriaceæ.

Dictyosphaerium ehrenbergianum Nägeli. Fayette Co. **D. pulchellum** Wood. Fayette Co., Hart Co.

Dimorphococcus lunatus A. Braun. Hart Co.

Autosporaceæ.

Actinastrum gracillimum G. M. Smith. Fayette Co., Garrard Co. **A. hantzschi** Lagerheim. Fayette Co., Hart Co.

Ankistrodesmus falcatus (Corda) Ralfs. Hart Co. var. **mirabilis** (W. & G. S. West) G. S. West. Fayette Co., Garrard Co., Jessamine Co. var. **tumidus** (W. & G. S. West) G. S. West. Fayette Co.

Closteriopsis longissima Lemmermann. Fayette Co.

Coelastrum cambricum Archer. Fayette Co. **C. microporum** Nägeli. Clark Co., Fayette Co., Hart Co.

Crucigenia crucifera (Wolle) Collins. Fayette Co. **C. fenestrata** Schmidle. Fayette Co. **C. quadrata** Morren. Bourbon Co., Fayette Co. **C. rectangularis** (Nägeli) Gay. Fayette Co. **C. tetrapedia** (Kirchner) W. & G. S. West. Fayette Co. **C. truncata** G. M. Smith. Hart Co.

Errerella bornheimensis Conrad. Fayette Co.

Gloeotaenium loitlesbergerianum Hansgirg. Clark Co.

Golenkinia paucispina W. & G. S. West. Hart Co. **G. radiata** Chodat. Fayette Co.

Kirchneriella contorta (Schmidle) Bohlin. Fayette Co. **K. lunaris** var. **irregularis** G. M. Smith. Fayette Co. **K. obesa** (W. West) Schmidle. Fayette Co. var. **major** (Bernard) G. M. Smith. Fayette Co.

Lagerheimia droescheri (Lemmermann) Printz. Fayette Co. **L. longiseta** (Lemmermann) Printz. Fayette Co. **L. subsalsa** Lemmermann. Fayette Co.

Micractinium pusillum Fresenius. Fayette Co. var. **elegans** G. M. Smith. Fayette Co.

Nephrocytium lunatum W. West. Hart Co.

Oocystis borgei Snow. Fayette Co. **O. elliptica** W. West. Clark Co., Jessamine Co., Nelson Co. **O. lacustris** Chodat. Fayette Co. **O. parva** W. & G. S. West. Fayette Co.

Quadrigula lacustris (Chodat) G. M. Smith. Jessamine Co.
Scenedesmus abundans (Kirchner) Chodat. Fayette Co. var. **brevicauda** G. M. Smith. Fayette Co. var. **longicauda** G. M. Smith. Fayette Co. **S. acuminatus** (Lagerheim) Chodat. Fayette Co. **S. acutiformis** Schröder. Barren Co., Clark Co., Fayette Co. **S. arcuatus** var. **platydisca** G. M. Smith. Fayette Co. **S. armatus** (Chodat) G. M. Smith. Fayette Co. **S. bernardii** G. M. Smith. Fayette Co. **S. bijuga** (Turpin) Lagerheim. Fayette Co., Hart Co., Jessamine Co. var. **alternans** (Reinsch) Borge. Fayette Co. **S. brasiliensis** Bohlin. Fayette Co. **S. denticulatus** Lagerheim. Fayette Co. **S. dimorphus** (Turpin) Kützing. Fayette Co., Jessamine Co. **S. obliquus** (Turpin) Kützing. Fayette Co., Jessamine Co. **S. opoliensis** P. Richter. Fayette Co., Hart Co. **S. quadricauda** (Turpin) Brebisson. Fayette Co., Hart Co. var. **longispina** (Chodat) G. M. Smith. Fayette Co. var. **parvus** G. M. Smith. Fayette Co. var. **quadrispina** (Chodat) G. M. Smith. Fayette Co., Jessamine Co. var. **westii** G. M. Smith. Fayette Co., Garrard Co.
Schroederia setigera (Schröder) Lemmermann. Fayette Co.
Selenastrum gracile Reinsch. Hart Co. **S. minutum** (Nägeli) Collins. Fayette Co. **S. westii** G. M. Smith. Fayette Co.
Sorastrum spinulosum Nägeli. Clark Co., Fayette Co.
Tetraedron enorme (Ralfs) Hansgirg. Clark Co. **T. limneticum** Borge. Fayette Co. **T. minimum** (A. Braun) Hansgirg. Fayette Co., Garrard Co., Hart Co. **T. pentaedricum** W. & G. S. West. Fayette Co. **T. planctonicum** G. M. Smith. Fayette Co., Hart Co. **T. regulare** Kützing. Fayette Co., Hart Co., Jessamine Co. var. **incus** Teiling. Hart Co. **T. trigonum** (Nägeli) Hansgirg. Fayette Co., Hart Co. var. **gracile** (Reinsch) de Toni. Fayette Co.
Trochiscia aspera (Reinsch) Hansgirg. Fayette Co.

ULOTRICHALES.

Ulotrichaceæ.

Ulothrix tenerrima Kützing. Fayette Co. **U. variabilis** Kützing. Fayette Co.
Cylindrocapsa geminella Wolle. Clark Co., Fayette Co.

Pleurococcaceæ.

Pleurococcus vulgaris Meneghini. Fayette Co.

Chaetophoraceæ.

Chaetophora elegans (Roth) Agardh. Hickman Co.
Draparnaldia acuta (Agardh) Kützing. Pike Co. **D. glomerata** (Vaucher) Agardh. Hickman Co.
Stigeoclonium stagnatile (Hazen) Collins. Fayette Co. **S. subsecundum** Kützing. Garrard Co. **S. tenue** (Agardh) Kützing. Fayette Co.

Coleochaetaceæ.

Coleochaete scutata Brebisson. Fayette Co.

Trentepohliaceæ.

Trentepohlia aurea (L.) Martius. Larue Co.

SIPHONOCLADIALES.

Cladophoraceæ.

Cladophora crispata (Roth) Kützing. Jessamine Co. **C. fracta** (Dillw.) Kützing. Fayette Co. **C. glomerata** (L.) Kützing. Barren Co., Jessamine Co., Nelson Co. **C. kuetzingiana** Grunow. Garrard Co. **C. uberrima** Lambert. Washington Co.
Pithophora varia Wille. Clark Co., Fayette Co., Jessamine Co.
Rhizoclonium crassipellitum var. **robustum** G. S. West. Fayette Co. **R. crispum** Kützing. Fayette Co. **R. hieroglyphicum** (Agardh) Kutzing. Bourbon Co., Clark Co., Fayette Co., Washington Co.

SIPHONALES.

Vaucheriaceæ.

Vaucheria geminata (Vaucher) de Candolle. Fayette Co., Pike Co., Scott Co. **V. hamata** (Vaucher) de Candolle. Fayette Co. **V. repens** Hassall. Fayette Co. **V. uncinata** Kützing. Carroll Co., Fayette Co.

STEPHANOKONTÆ.

OEDOGONIALES.

Oedogoniaceæ.

Bulbochaete insignis Pringsheim. Hart Co.
Oedogonium cardiacum var. **minus** Lemmermann. Fayette Co. **O. crassiusculum** var. **arechavaletae** (Wittrock) Hirn. Hardin Co. var. **idioandrosporum** Nordstedt & Wittrock. Hart Co. **O. crenulatocostatum** Wittrock. Hickman Co. **O. crispum** var. **gracilescens** Wittrock. Hart Co. **O. gallicum** Hirn. Hart Co. **O. gracillimum** Wittrock & Lund. Hart Co. **O. hirnii** Gutwinski. Hart Co., Hickman Co. **O. illinoisense** Transeau. Hart Co. **O. intermedium** Wittrock. Hart Co. **O. iowense** Tiffany. Hart Co. **O. latiusculum** Tiffany. Clark Co. **O. lautumniarum** Wittrock. Fayette Co. **O. multisporum** Wood. Harrison Co. **O. pachyandrium** Wittrock. Hart Co. **O. plagiostomum** var. **gracilius** Wittrock. Fayette Co., Hart Co. **O. sexangulare** Cleve. Hart Co.

AKONTÆ.

ZYGNEMALES.

Zygnemaceæ.

Debarya decussata Transeau. Barren Co.

Mougeotia sphaerocarpa Wolle. Hart Co.

Spirogyra affinis (Hassall) Petit. Fayette Co. **S. communis** (Hassall) Kützing. Fayette Co., Hart Co. **S. condensata** (Vaucher) Kützing. Fayette Co., Jessamine Co. **S. decimina** (Muller) Kützing. Fayette Co. var. **crassior** Gutwinski. Fayette Co. var. **inflata** Fritsch. Fayette Co. var. **plena** W. & G. S. West. Fayette Co. var. **triplicata** Collins. Fayette Co. **S. farlowii** Transeau. Fayette Co. **S. juergensii** Kützing. Fayette Co., Hardin Co., Hart Co., Jessamine Co., Larue Co. **S. lagerheimii** Wittrock. Clark Co. **S. longata** (Vaucher) Kützing. Fayette Co., Jessamine Co., Scott Co. **S. nitida** (Dillwyn) Link. Clark Co., Fayette Co. **S. porticalis** (Muller) Cleve. Fayette Co. **S. protecta** Wood. Jessamine Co. **S. punctata** Cleve. Hart Co. **S. quadrata** (Hassall) Petit. Fayette Co. var. **bifaciata** Kirchner. Clark Co. **S. rivularis** (Hassall) Rabenhorst. Larue Co. **S. singularis** Nordstedt. Harrison Co., Washington Co. **S. stictica** (Eng. bot.) Wille. Jefferson Co. **S. varians** (Hassall) Kutzing. Fayette Co., Jessamine Co. var. **minor** Teodoresce. Clark Co., Fayette Co. var. **scrobiculata** Stockmayer. Clark Co., Fayette Co. **S. velata** var. **occidentalis** Transeau. Carroll Co., Fayette Co. **S. weberi** Kützing. Jefferson Co., Jessamine Co.

Zygnema insignis (Hassall) Kützing. Carroll Co. **Z. stellinum** (Vaucher) Agardh. Carroll Co., Fayette Co.

DESMIDIALES.

Mesotaeniaceæ.

Netrium digitus (Ehrenberg) Itzingsohn & Rothe. Barren Co.

Desmidiaceæ.

Arthrodesmus subulatus var. **subaequalis** W. & G. S. West. Hart Co.

Closterium acerosum (Schrank) Ehrenberg. Fayette Co., Jessamine Co., Larue Co. var. **elongatum** Brebisson. Fayette Co. **C. calosporum** Wittrock. Fayette Co. **C. cynthia** De Not. Jessamine Co. **C. dianæ** Ehrenberg. Fayette Co. **C. didymotocum** Corda. Campbell Co., Hart Co. **C. ehrenbergii** Meneghini. Clark Co., Fayette Co., Hart Co., Jessamine Co., Larue Co. **C. gracile** Brebisson. Fayette Co. **C. intermedium** Ralfs. Campbell Co. **C. juncidum** Ralfs. Hart Co. var. **brevior** Roy. Hart Co. **C. lanceolatum** Kützing. Bourban Co. **C. leibleinii** Kutzing. Fayette Co., Garrard Co., Hart Co., Jessamine Co., Nelson Co. **C. lineatum** Ehrenberg. Hart Co., Jessamine Co. **C. lunula** (Muller) Nitzsch. Fayette Co., Jessamine Co. **C. macilentum** Brebisson. Hart Co. **C. moniliferum** (Bory) Ehrenberg. Bourban

Co., Fayette Co., Hart Co., Jessamine Co. **C. parvulum** Nageli. Barren Co. **C. peracerosum** Gay. Fayette Co. **C. praelongum** Brebisson. Fayette Co. **C. pritchardianum** Archer. Fayette Co., Hart Co., Jessamine Co., Wolfe Co. **C. ralfsii** var. **hybridum** Rabenhorst. Pike Co. **C. regulare** Brebisson. Hart Co. **C. rostratum** Ehrenberg. Hart Co. **C. strigosum** Brebisson. Larue Co. **C. striolatum** Ehrenberg. Hart Co. **C. subulatum** (Kutzing) Brebisson. Hart Co. **C. venus** Kützing. Fayette Co., Hart Co.

Cosmarium biretum Brebisson. Fayette Co., Hardin Co., Harrison Co., Jessamine Co., Larue Co. **C. botrytis** var. **gemmiferum** (Brebisson) Nordstedt. Fayette Co. var. **mediolaeve** West. Fayette Co. **C. broomei** Thwaites. Hart Co., Jessamine Co., Washington Co. **C. calcareum** Wittrock. Fayette Co. **C. commissurale** Brebisson. Hart Co. **C. contractum** Kirchner. Fayette Co., Hart Co. **C. cucumis** (Corda) Ralfs. Fayette Co. **C. fastidiosum** W. & G. S. West. Fayette Co. **C. formulosum** Hoff. Fayette Co. var. **nathorstii** (Boldt) W. & G. S. West. Jessamine Co. **C. granatum** Brebisson. Barren Co., Fayette Co., Hart Co., Jessamine Co., Washington Co. **C. isthmochondrum** Norstedt. Fayette Co. **C. laeve** Rabenhorst. Clark Co., Fayette Co. **C. margaritatum** (Lundell) Roy & Bliss. Hart Co. **C. meneghinii** Brebisson. Fayette Co. **C. nagelianum** Brebisson. Fayette Co. **C. obtusatum** Schmidle. Barren Co., Hart Co., Larue Co., Washington Co. var. **beanlandii** W. & G. S. West. Jessamine Co. **C. ochthodes** Nordstedt. Hart Co., Larue Co. **C. orthostichum** var. **compactum** W. & G. S. West. Fayette Co. **C. ovale** Ralfs. Hart Co. **C. portianum** Archer. Barren Co., Hart Co. var. **nephroideum** Wittrock. Hart Co. **C. pseudobroomei** Wolle. Hart Co. **C. pseudoconnatum** var. **ellipsoideum** W. & G. S. West. Hart Co. **C. pygmaeum** Archer. Clark Co., Hart Co., Larue Co. **C. pyramidatum** Brebisson. Hart Co. **C. quadrum** Lundell. Hart Co. **C. regnelli** Wille. Fayette Co., Jessamine Co. **C. reniforme** (Ralfs) Archer. Bourban Co., Carroll Co., Fayette Co., Jessamine Co., Larue Co. var. **apertum** W. & G. S. West. Clark Co., Fayette Co., Hart Co., Jessamine Co., Washington Co. **C. sexnotatum** var. **tristriatum** (Lutkem) Schmidle. Clark Co. **C. subcrenatum** Hantzsch. Jessamine Co., Washington Co. **C. subnotabile** Wille. Fayette Co. **C. subreniforme** Nordstedt. Hart Co. **C. succisum** West. Hart Co. **C. taxichondrum** Lundell. Hart Co. **C. tetraophthalmum** Brebisson. Hart Co. **C. turpinii** Brebisson. Bourban Co., Carroll Co., Fayette Co., Harrison Co., Hart Co., Jessamine Co., Larue Co., Washington Co. var. **eximium** W. & G. S. West. Barren Co. **C. ungerianum** var. **subtriplicatum** W. & G. S. West. Larue Co.

Desmidium aptogonum var. **acutius** Nordstedt. Hart Co. **D. baileyi** (Ralfs) Nordstedt. Hart Co. **D. cylindricum** Greville. Hart Co. **D. swartzii** Agardh. Hart Co., Hickman Co.

Euastrum ansatum Ralfs. Larue Co. **E. denticulatum** (Kirchner) Gay. Hart Co. **E. dubium** var. **anglicanum** (Turner) W. & G. S. West. Hart Co. **E. elegans** (Brebisson) Kützing. Hart Co.

E. gemmatum Brebisson. Campbell Co. **E. glaziovii** Borgensen. Hart Co. **E. insulare** (Wittrock) Roy. Hart Co. **E. obesum** Josh. Campbell Co., Hart Co. **E. oblongum** var. **cephalophorum** West. Hart Co. **E. verrucosum** Ehrenberg. Hart Co., Larue Co.

Hyalotheca dissiliens (Smith) Brebisson. Hart Co., Rowan Co.

Micrasterias americana (Ehrenberg) Ralfs. Hart Co. **M. denticulata** Brebisson. Hart Co. **M. laticeps** Nordstedt. Hart Co. **M. radiata** Hassall. Hart Co. **M. truncata** (Corda) Brebisson. Fayette Co.

Onychonema laeve Nordstedt. Hart Co. var. **latum** W. & G. S. West. Hart Co.

Penium closterioides Ralfs. Fayette Co., Hart Co. **P. curtum,** forma **major** Wille. Fayette Co. **P. margaritaceum** (Ehrenberg) Brebisson. Barren Co., Fayette Co., Hart Co., Larue Co., Nelson Co. **P. minutum** (Ralfs) Cleve. Hart Co. **P. spirostriolatum** Barker. Hart Co.

Pleurotaenium coronatum var. **nodulosum** (Brebisson) West. Hart Co. **P. ehrenbergii** var. **undulatum** Schaarschmidt. Hart Co. **P. trabecula** (Ehrenberg) Nägeli. Campbell Co., Fayette Co., Hart Co., Scott Co.

Spondylosium secedens (De Bary) Archer. Hart Co.

Staurastrum alternans Brebisson. Fayette Co., Hart Co. **S. anatinum** var. **denticulatum** G. M. Smith. Fayette Co., Jessamine Co. **S. bieneanum** Rabenhorst. Fayette Co., Hart Co. **S. botrophilum** Wolle. Larue Co. **S. chaetoceras** (Schröder) G. M. Smith. Bourban Co., Fayette Co. **S. cuspidatum** Brebisson. Hart Co. **S. dickiei** var. **circulare** Turner. Hart Co. **S. gladiosum** Turner. Hart Co. **S. manfeldtii** Delponte. Fayette Co. **S. muticum** Brebisson. Fayette Co. **S. paradoxum** var. **parvum** West. Fayette Co. **S. polymorphum** Brebisson. Barren Co., Carroll Co., Clark Co., Fayette Co., Hart Co., Jessamine Co., Larue Co. **S. pseudotetracerum** (Nordstedt) W. & G. S. West. Fayette Co. **S. striolatum** (Nägeli) Archer. Barren Co., Fayette Co., Garrard Co., Hart Co., Jessamine Co. **S. tetracerum** (Kützing) Ralfs. Hart Co.

Xanthidium antilopaeum var. **minneapoliense** Wolle. Hart Co. var. **polymazum** Nordstedt. Hart Co. **X. cristatum** Brebisson. Hart Co.

EUGLENINEÆ.

Euglenaceæ.

Euglena spirogyra Ehrenberg. Campbell Co.

The following is a summary of all forms found, giving the numbers of species for each of the classes, sub-classes, orders, families, and genera:

MYXOPHYCEAE, 68.

CHROOCOCCEÆ..... 21
CHROOCOCCALES..... 21
Chroococcaceæ..... 21
Aphanocapsa..... 2
Aphanothece..... 1
Chroococcus..... 3
Coelosphaerium..... 3
Gloeocapsa..... 1
Gomphosphaeria..... 2
Merismopedia..... 5
Microcystis..... 4
HORMOGONEÆ..... 47
HORMOGONEALES..... 47
Oscillatoriaceæ..... 25
Lyngbya..... 5
Microcoleus..... 1
Oscillatoria..... 13
Phormidium..... 5
Spirulina..... 1
Nostocaceæ..... 19
Anabaena..... 7
Aphanizomemnon..... 1
Cylindrospermum..... 5
Nodularia..... 1
Nostoc..... 5
Scytonemataceæ..... 1
Scytonema..... 1
Rivulariaceæ..... 2
Calothrix..... 1
Gloeotrichia..... 1

CHRYSOPHYCEAE, 1.

OCHROMONADALES..... 1
Ochromonadaceæ..... 1
Dinobryon..... 1

RHODOPHYCEAE, 1.

FLORIDEÆ..... 1
NEMALIONALES..... 1
Lemanaeceæ..... 1
Lemanea..... 1

HETEROKONTEAE, 5.

HETEROTRICHALES..... 4
Tribonemaceæ..... 4
Tribonema..... 4
HETEROSIPHONALES..... 1
Botrydiaceæ..... 1
Botrydium..... 1

CHLOROPHYCEAE, 298.

ISOKONTÆ..... 130
VOLVOCALES..... 8
Chlamydomonadaceæ..... 1
Chlamydomonas..... 1
Volvocaceæ..... 7
Eudorina..... 1
Gonium..... 1
Pandorina..... 1
Pleodorina..... 2
Volvox..... 2
CHLOROCOCCALES..... 95
Palmellaceæ..... 6
Gloeocystis..... 1
Planctosphaeria..... 1
Sphaerocystis..... 1
Tetraspora..... 3
Hydrodictyaceæ..... 14
Hydrodictyon..... 1
Pediastrum..... 13
Chlorococcaceæ..... 3
Characium..... 2
Chlorococcum..... 1
Dictyosphaeriaceæ..... 3
Dictyosphaerium..... 2
Dimorphococcus..... 1
Autosporaceæ..... 69
Actinastrum..... 2
Ankistrodesmus..... 3
Closteriopsis..... 1
Coelastrum..... 2
Crucigenia..... 6
Errerella..... 1
Gloeotaenium..... 1
Golenkinia..... 3
Kirchneriella..... 4
Lagerheimia..... 3
Micractinium..... 2
Nephrocytium..... 1
Oocystis..... 4
Quadrigula..... 1
Scenedesmus..... 20
Schroederia..... 1
Selenastrum..... 3
Sorastrum..... 1
Tetraedron..... 9
Trochiscia..... 1
ULOTRICHALES..... 12
Ulotrichaceæ..... 2
Ulothrix..... 2
Cylindrocapsaceæ..... 1
Cylindrocapsa..... 1
Pleurococcaceæ..... 1
Pleurococcus..... 1
Chaetophoraceæ..... 6
Chaetophora..... 1
Draparnaldia..... 2
Stigeoclonium..... 3
Coleochaetaceæ..... 1
Coleochaete..... 1
Trentepohliaceæ..... 1
Trentepohlia..... 1

SIPHONOCLADIALES	11
Cladophoraceæ	11
Cladophora	5
Pithophora	1
Rhizoclonium	5
SIPHONALES	4
Vaucheriaceæ	4
Vaucheria	4
STEPHANOKONTÆ	18
OEDOGONIALES	18
Oedogoniaceæ	18
Bulbochaete	1
Oedogonium	17
AKONTÆ	150
ZYGNEMALES	30
Zygnemaceæ	30
Debarya	1
Mougeotia	1
Spirogyra	26
Zygnema	2
DESMIDIALES	120
Mesotaeniaceæ	1
Netrium	1
Desmidiaceæ	119
Arthrodesmus	1
Closterium	27
Cosmarium	42
Desmidium	4
Euastrum	10
Hyalotheca	1
Micrasterias	5
Onychonema	2
Penium	5
Pleurotaenium	3
Spondylosium	1
Staurastrum	15
Xanthidium	3
EUGLENINEAE, 1.	
Euglenaceæ	1
Euglena	1

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1912. Ibid. IV: 191. Pls. 96–128, 467 figs.
1923. Ibid. V: 300. Pls. 129–167, 564 figs.
Volume V by **Dr. Nellie Carter.**

A COMMUNITY OF CHARITY CASES.*

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Steele High School, Dayton, Ohio.

Since charity work in many cities has been organized as a community project, the character of the person helped becomes a question of concern to the average citizen. That families making repeated appeals for aid have some common characteristics might be expected. This study was begun as an attempt to find some of these common factors in an Ohio city with a population of 150,000. This City was among the first to adopt the "Community Chest" plan and the charity work is well organized. The cases selected were those of families who had applied many times for aid through the organized charities. The files of the Family Welfare Association furnish a history of the cases that have come to their attention since 1913. From these records over fifty cases were reviewed and twenty-nine of these cases form the basis of this study. In following up these histories with field observations seventy homes were visited and one hundred and fifty of the persons charted seen.

A problem which presented itself early in the field work was locating the families. Unless the appeal for aid had been very recent, the records of the Family Welfare Association could be of little use. Tracing the residence record of the family is not a problem of the Association as the family will sooner or later make an appeal from the new address. In a re-check of ten families after a six-months' period, six were found at new addresses and one family had moved twice. With so much shifting it was surprising to find that few members of the families studied had ever left the city after once establishing their residence. One reason for this continuous residence is found in the policy of organized charities to give substantial relief only to their own citizens. When this study was begun three of the families were stranded in Davenport, Iowa. They had started west and their automobiles had broken down at that place. The Associated Charities of Davenport decided that an investment in transportation would be more profitable

*Contribution No. 101 from the Department of Zoology and Entomology, Ohio State University.

than an uncertain expenditure for food and clothing, so the three families, eighteen persons in all, were helped back to the city. One of these families has applied for aid at the Family Welfare Association since its return.

Not only has their residence in the city been continuous, but most of the families, when finally located, were found within a very limited area of the city. Two areas, both in the poorer residential parts of the city, seemed especially favored. Although separated by the river, railroads, and factory district, these two areas belong to adjoining school districts. The only members of the group not in these areas were those who had moved out into adjacent plats where small houses could be had at low rent.

Housing conditions were of the poorest and none of the homes were in good repair. Many lived in antiquated tenement houses with three or four rooms to an apartment, small cottages, often on alleys, or rooms. These rooms were usually upstairs or in the rear. The rent ranged from ten to twenty dollars per month. Often two families occupied the same rooms. In only two cases did a family occupy a two-story house by themselves. In a few cases "rooms" were rented "furnished," some families owning only a little bedding and a few dishes. Despite the fact that most of the homes were meagerly furnished there was usually an effort at cleanliness and some homes were quite neat.

For the most part the men were the sole bread winners but occasionally the men were found at home while the women were out at work. Four such cases were found, or about six per cent of the homes visited. The employment of the men was limited to a few classes of work, mainly laborers, truck drivers, and helpers. None had any definite trade and few worked in shops, although a small group aspired to be contractors in painting. Because of the uncertainty of weather conditions, many were forced to be idle much of the time. Truck drivers with regular routes and helpers in filling stations were the most prosperous. If the class of labor done is a criterion, this group is below the level of the average in intelligence.

The women working outside the home were usually in restaurants and bakeries. One did sewing at home and one worked in a factory. Because the housekeeping efforts are so successful one is apt to over-estimate the mentality of the

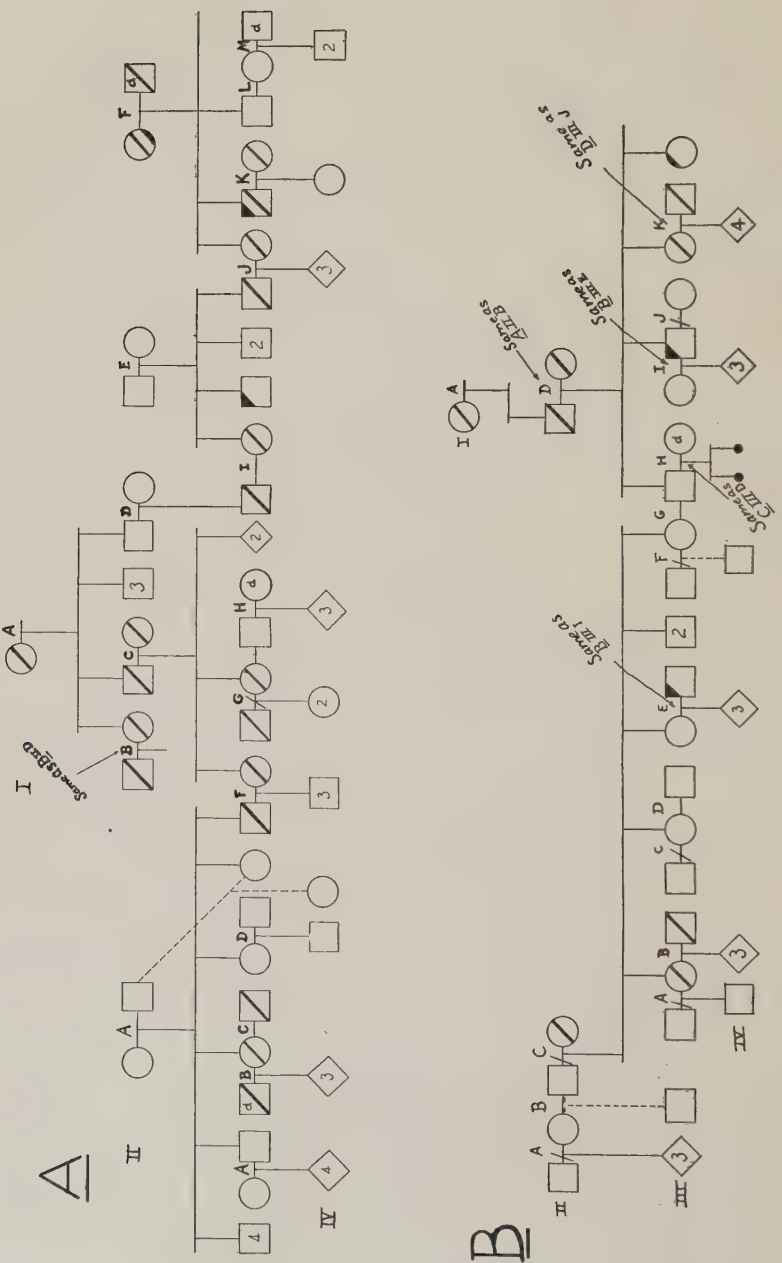
home keeper. A little questioning regarding persons and events, and more especially questions concerning directions and locations, reveals the intelligence of the women on a par with that of the men.

The school attainment of the children is limited to the sixth and seventh grade. Four of the children have been in "special classes" and most of the others are below the school grade usual for their age. Of the twenty-nine children above the first grade there was a total retardation of forty-three years. This is a year's work for one teacher. This group of twenty-nine was receiving one-third more attention than the average school group of its size.

Taking the cases from court records, certain types of crime are found to be common. Three have been convicted of theft, one of boot-legging and two of peddling dope. Sex offences are frequent in some families. There are three illegitimate children in the group, one being a case of incest. The record of one family is striking in that nearly all have been divorced and re-married. Separations and desertions are frequent occurrences. Early marriage is common within the group. There are few single men or women over twenty years of age. One fifty year old woman had a married granddaughter.

Several of the families selected were found to be related through marriage. Two large related groups of families each connected with a third large family which, though usually thrifty enough to tide itself over times of stress, was still close to the borderline of dependence. Using this family as a connecting factor all the group resolved itself into an inter-related community. The situation is strikingly similar to that of an isolated rural community of the last century. The social barriers separating the group from its neighbors are as effective as distance was to the frontiersman. The other cases reviewed from the Family Welfare Association records show the same tendencies to remain within a limited area and intermarry within their own group. The accompanying chart shows the relationships among the families visited.

Some of the families were most striking in their dependence on charity. N. C—— whose father is in the County Infirmary has received aid while she was living with each of her two husbands. Two of her brothers have received aid and her youngest son received extra attention in a "special" class in


A
B
I
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C
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Dead Infant
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4 Children
I-IV Generations
d Dead
Male
Female
Charity
Crime
Institutional Care
A-D Groups

school. Her oldest daughter will probably need assistance for some time, as she is separated from her husband, and is trying to care for her four children. The father's assistances to the support of these children is gotten by the Humane Society, and they must re locate him frequently because of his attacks of wanderlust. W——'s mother has gotten help at various times so has W—— and two of his daughters, also a nephew and the nephew's brother-in-law. In the family of D—— three generations have received help, so also has the L—— family.

The rehabilitation of one of these families is always temporary. Only under the most favorable conditions can they remain self-supporting. Both parents and children come for help whenever the conditions become adverse. Institutional care is the future of those who outlive their earning period, for the family is never able to carry the burden of an additional unproductive member. When the study was made five of the group were being kept in some tax supported institution and one other living member had been in the State Hospital on two occasions.

If the children of those families which have received aid through the Welfare Association are considered by themselves, the incidence of dependence is striking. When the parents of one or both parties have received help the chances are about two to one that the family will apply for aid by the time a second child is born. And it will be remembered that the Welfare records cover a period of only sixteen years.

Although the selection of cases implied a long residence in the city there was found to be a wide range in the length of residence. One gray-haired woman, with her husband in an institution for epileptics, a daughter in a T. B. sanitarium, and a son at large, had spent her entire life within a dozen blocks of where she was born. Others have been in the city only a few years. The greatest influx of these families seems to have been from 1910 to 1915. The movement into the city aside from a few coming in from nearby farms and villages was very largely from the south. The hill country of Kentucky and Tennessee furnished more than 60% of the families. A study of the surnames is significant. English, Irish and Scotch names predominate. It would be interesting to trace these family names back to the early Colonial settlers and to England.

The vigorous robust individual is a rare exception in this group. One boy is interested in baseball and plays on a neighborhood sand lot team. He is the only one inclined toward athletics. Most of the men are below the average in size and apparently underweight. Their power of disease resistance is much below the average. One very common form of charity accepted by them is the free clinic and hospital service. This impression may have been gained by their willingness to talk of their hospital experiences.

The question of drunkenness is ignored. It is assumed that drunkenness is an effect of some more remote cause. Attitudes on the liquor question are as one finds them in any group. Many spoke of drinking among others in the group but usually about those for whom they had a dislike. Just how much drinking was excused among friends one could only surmise.

Generalizing on so few cases can hardly be done with satisfaction but some conditions are so common as to be outstanding. A most striking characteristic was the unquestioning willingness of the subject to give information. This, in my opinion, is associated with the child-like simplicity of the feeble-minded. The willingness to answer questions was all the more noticeable as the investigator went as an individual, not backed by an organization. Had the subject thought that a charity organization was interested excuses to apply for aid would have been forth-coming.

Another characteristic noticed was the cheerful, hopeful outlook on life. Very few were despondent. There is a record of one suicide but this seems to have been started by a bluff and the disasterous turn in the situation was unexpected. Their attitude toward help from the outside seemed to be a passive one. There was little insistance on charity as an inherent right.

These families are living in a poor neighborhood under poor housing conditions with poor food and clothing. Their immediate environment offers little and they can not take advantage of the opportunities for advancement offered them through the schools and other educational agencies. Their ancestors in the hill country failed to meet successfully the simple demands of a rural life and the children are experiencing more difficulties in meeting the complex life of the city. In trying to determine a

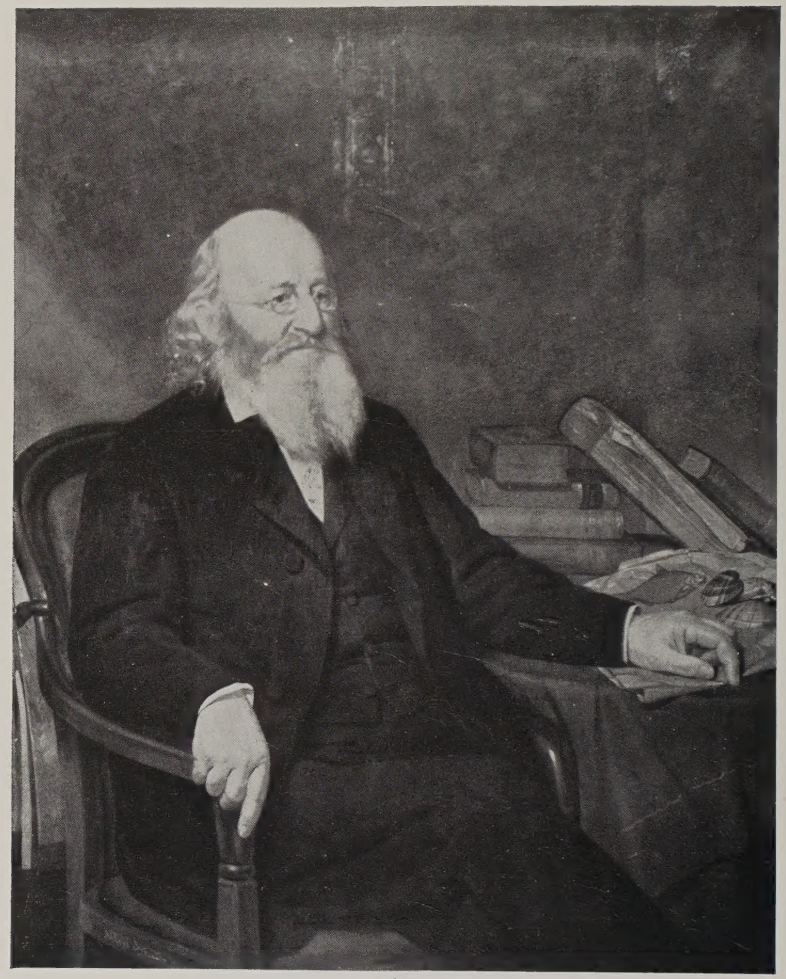
single causal factor contributing to their delinquency one has a problem as complex as that of Father Jupiter in "The Bridge of San Luis Rey." In general, one can say that the inherited factors which keep them dependent lie within the comprehensive grouping of mental status known as feeble-mindedness.

ANNUAL MEETING

OF THE

OHIO ACADEMY OF SCIENCE.

Notices of the Spring meeting of the Ohio Academy of Science have been sent to all members but for the benefit of any not now connected with the Academy it may be noted that the meetings will be held at the Ohio State University, Botany and Zoology Building, April 18 and 19. Those interested in Science are welcome to these meetings and to membership in the Academy. Applications for membership may be sent to the Secretary, Mr. W. H. Alexander, Weather Bureau, Columbus, Ohio.



(From an oil painting done by Allen Smith in 1870.)

JARED POTTER KIRTLAND
1793—1877

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